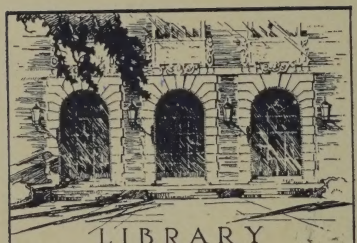

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MASSAGE AND THERAPEUTIC EXERCISE

BY

MARY McMILLAN

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SECOND EDITION, RESET

PHILADELPHIA AND LONDON

W. B. SAUNDERS COMPANY

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FOREWORD

THE war has given opportunity to add knowledge and experience to many of the medical problems which were having consideration before this period, and this is particularly so in the Physiotherapies. The value of this feature of treatment, as well as its more accurate and intelligent application, had a marked impetus by the excellent work with its results done in England, France, and Canada, and the very large number of cases requiring these measures for prolonged periods emphasized the results which may be expected by it. Its use after acute infections and in the after-treatment of fractures and nerve injuries has been placed on an entirely new plane, and the different forms of the Physiotherapies have had the test of their comparative value by this experience. All of this has given opportunity for compiling the knowledge gained during this period and for formulating the various methods of its use, as well as for estimating the comparative value of the various forms.

Miss McMillan came to this department of medical war service well equipped by training and former experience, and in her position had extensive opportunity

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of observing the various forms of Physiotherapy and of studying their practical results, as well as the opportunity, during the same period, of teaching the aides who were enrolled for this purpose. We are fortunate to have at this early date the advantage of this recent experience brought into such shape that its employment may have wider application in civil practice, and that it may be used toward the relief of industrial cases which are to need the same kind of service. It has been the desire of all who were occupied with the physical reconstruction of the injured during the war to so preserve the resources developed during this period that they may be turned to the relief of the industrial reconstruction, which problem we shall always have with us. Miss McMillan's contribution is, therefore, particularly timely, and is to be recommended to those who are interested in the parts of Physiotherapy which comprise manual massage and therapeutic exercise.

E. G. Brackett,
Formerly Colonel Med. Corps., U. S. A.

PREFACE TO THE SECOND EDITION

In view of the fact that Physiotherapy is more widely used at the present time in various departments of large hospitals, and that industrial accident clinics are more and more specializing in Physiotherapy as one of their most important features, it has seemed advisable to revise much of the presentation and outline of treatment.

The text has been completely revised and amplified in regard to the use of prescribed therapeutic exercise.

The treatment of recent fractures has been rewritten. Drawings of modern apparatus have been added, both for fractures and different kinds of therapeutic exercise.

Thanks are due to Dr. Frederic J. Washburn for permission to use the drawings of apparatus from "Outline of Fractures" from a Syllabus of the Massachusetts General Hospital.

Thanks are also extended to Dr. E. G. Brackett and Dr. Frederic J. Cotton for constructive criticism, to Dr. Louis Colleen and to Mrs. Clara M. Eisenbrey for helpful suggestions in some of the text, to Dr. Frank B. Granger for his outline of minimum electrotherapy equipment in the Appendix, and to Mr. Thomas Burns for his drawing of a hydriatic plant.

Mary McMillan.

Boston, Mass.,
October, 1925.

PREFACE

The United States Army Medical Corps, through the Physiotherapy Division of the Reconstruction Department, made it possible from March, 1918 to March, 1920 for about 86,000 disabled soldiers to have the benefit of over three and one-half million treatments in the General Army Hospitals and camps throughout the United States. In addition, hundreds of men in France were able to receive treatments.

Because of the results achieved in the war emergency work physical therapeutic measures have already found favor, and the public is demanding that they be added to the science and art of healing wherever such treatment is indicated.

Physical therapeutics is by no means a new form of therapy, although hitherto the application has been limited chiefly to the orthopedic field.

About 1880 Dr. Weir Mitchell and Dr. Douglas Graham by their practice, teachings, and books were such strong advocates of massage that they aroused an interest among the medical profession in the United States. Claes J. Enebuske, Ph.D., Baron De Posse, Dr. Colleen, and Dr. D. A. Sargent organized and established a standard for normal training-schools of Physical Education. The first conference on this subject in the country was held November 29 and 30, 1889 in Boston, Mass.

In 1917 Dr. E. G. Brackett and Dr. Joel Goldthwait were interested in the reconstruction work that was being done among the Allied nations. They were the inaugurators of the Reconstruction Department of the United States Army in the early part of 1918. The department consisted of the Physiotherapy, Occupational Therapy, and Curative Workshop Divisions.

Soon after the formation of the department a demand arose for trained workers both for the Army Hospitals in the United States and for overseas service. A special appeal was made to the recognized schools of physical education throughout the country, and short, intensive courses of instruction were arranged in order to train women to meet the demand. These special training courses fitted about 800 women for the Physiotherapy Division. In June, 1918 the first overseas unit of Reconstruction Aides was ordered to France, and reported for duty at the United States Army Base Hospital No. 114.

At the same time there was a small group of faithful women ministering to the needs of returned soldiers at the Walter Reed General Army Hospital in Washington, D. C., with whom I was privileged to be associated. As the need for more trained women became urgent my work at Washington was interrupted for several months in order that I might assist in the training courses that were being given for women at Reed College, in Portland, Oregon.

At the Congress of American Physicians and Surgeons in June, 1919, at Atlantic City, Dr. Harvey Cushing

stated, "This has come to the minds of all, and mayhap a new profession for women as important as the nursing profession may arise through their invaluable services as Reconstruction Aides." Undoubtedly the courses of instruction, along with a period of practical work, have provided for many women an introduction into a new field of service.

Physical therapeutic methods are based solely upon the known facts of anatomy and physiology and are sound and rational. The practice of these methods requires an acquaintance with the pathologic conditions and symptomatology, together with a knowledge of the laws of electrophysics.

There are four distinct branches in Physical Therapeutics, namely, Massage, Therapeutic Exercise, Electrotherapy, and Hydrotherapy. The application of dry heat and radiant light in its various forms is prescribed in certain types of cases. There is a large field for future study in this subject. The linking of the various branches that comprise the subject as a whole, and the testing of the combination of one branch with another in order to obtain the most beneficial results are still matters for serious consideration.

This book has been written not only for students but also for the women who have passed through short, intensive courses of theory and practice, many of whom will not be satisfied until they have reached a higher standard of efficiency.

I want to thank my many staunch friends and co-workers in the Reconstruction Department at the Walter Reed Army Hospital in Washington for their never-failing interest and patient aid in gathering and compiling the material for this book. My hearty thanks are extended to my friend Miss Emma Heilman. To Dr. E. G. Brackett, for his kindness and for the loan of many pictures; to Major Burt Carr, for his personal interest in the cardiovascular exercises, also for his contribution on two typical cardiovascular cases treated by graded exercises; to Dr. Frederic J. Cotton, for his keen interest and constructive criticism, and for the reprint of his pictures of a Volkmann's contracture; to Lieut.-Col. Coburn, Dr. Harvey Cushing, Dr. Frank B. Granger, Sir Robert Jones, Dr. Harry H. Kerr, Captain Mearns, and Dr. Harry Beal Torrey, for their help, kind suggestions, and letters of interest my most sincere thanks are due. Especially I want to express to Mr. Arthur Charles Watkins my warm appreciation of all his labor in connection with the editing of the book.

In conclusion, I should like to say that the spirit of loyalty, helpfulness, and co-operation that characterized the Reconstruction Department from the start was a large factor in achieving splendid results in the restoration of function and re-education of many disabled soldiers, thus enabling them to resume the activities of life.

MARY MCMILLAN.

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Massage and Therapeutic Exercise

PART I

MASSAGE

CHAPTER I

EFFLEURAGE; PETRISSAGE; FRICTION; TAPOTEMENT; VIBRATION; PHYSIOLOGIC AND THERAPEUTIC EFFECTS OF SAME

The word "massage" is derived from the Greek, and means to knead or press. It has come into modern use through the French, as is shown by several of the associated terms. It implies a scientific manipulation of the body tissues. It is a means for creating energy when it has become exhausted from any cause, and is a natural method of restoring the part injured or even the body as a whole to its normal condition.

The body tissues directly influenced by massage are the skin, the fascia, the muscular system, and the nervous system. The glandular, digestive, and bony systems are indirectly influenced. By reflex action through the sensory nerves in the skin a sedative effect is produced by manipulation. The muscles and soft tissues

are bound together by the deep and superficial fascia, between the layers of which are many large blood-vessels. The contraction and relaxation of the blood-vessels have their beneficial effect in improving the nourishment in the cells of the entire body. The muscles are strengthened and made to grow by manipulation because increased nutrition is brought to the part through the blood-stream. By the physiologic shortening of muscle-fibers the venous and lymphatic systems are affected. Each time muscle contraction takes place blood is forced through the veins, and the absorption of lymph is increased through the lymphatic vessels, accelerating the flow of the arterial blood, with its fresh supply of nutriment and oxygen. The motor and sensory nerves of the cerebrospinal system and of the autonomic or sympathetic system may be stimulated or soothed according to the character of the manipulation used.

In order to show what physiologic objects may be attained by massage it is necessary to discuss the various forms of manipulations used, and then to show how the different forms of manipulation, coupled with movements to joints, gain certain definite physiologic objects.

Massage and therapeutic exercise have definite physiologic objects in view in every phase of their practice. Massage, as the term is generally used, includes both manipulation of soft tissues and movements to joints.

Massage will be considered as manipulation of soft tissues, or as movements done *upon* the body; and therapeutic exercise will be considered as movements with the joints, or movements done *with* part of the body. These two measures, used one along with the other, or independently, form the basis of physical therapeutics.

There are five fundamental procedures in massage: effleurage, petrissage, friction, tapotement, and vibration. From these five a large variety of manipulations may be derived.

EFFLEURAGE

Effleurage, or movements of a stroking nature, in which the whole of the palmar surface of the hand is used, may be performed in two ways: first, by light stroking; second, by deeper stroking. Light stroking is used in the early stages of treatment or when deeper stroking cannot be tolerated by the patient. Although light, the stroke is firm and even, as undetermined stroking shows a lack not only in the understanding of technic but also of the patient's feelings.

Light stroking, even in its lightest form, has definite therapeutic effects. This type of effleurage, however, is perhaps one of the very hardest to perform, because it requires a great deal of aptitude as well as finished technic on the part of the operator. Stroking of this nature will be discussed in the chapter on Recent Fractures, where the Lucas-Championnière method is discussed.

Deeper stroking, or the usual manner of administering effleurage, is performed with a firm, even pressure. A definite amount of body surface should be decided upon by the operator before the hand attempts to start the stroke. For example, thorough stroking of the whole arm involves the following operations: First, from the finger-tips to just beyond the wrist-joint; second, from below the wrist-joint to just beyond the elbow-joint; third, from below the elbow-joint to just beyond the shoulder-joint.

It will be noticed in each subdivision that the stroke is carried from just below the distal joint to just beyond the proximal, the object being to carry the lymph to the proximal glands in order that it may be taken on through the lymphatics, back to the right side of the heart. The whole of the palmar surface of the operator's hand is used, and too much emphasis cannot be laid upon firm, even, rhythmic stroking. The thumb-to-thumb rule, which Douglas Graham so strongly advocates in his book on Massage, is admirable.

An operator who cannot use one hand as well as the other is not only limited in performing the normal operations of the work, but is a 50 per cent. worker. Therefore, from the start, one should practice more with the lesser developed hand as soon as some ability to perform certain manipulations is acquired. Great care should be taken to put pressure on the upward stroke, allowing the hand to return to its orig-

inal position without pressure, but without losing contact with the part being massaged. The fingers of the operator in performing effleurage should be held close together, but not stiffly. Relaxation on the part of the patient is necessary. The greater the facility of the operator to mold the hand into the part being massaged, the better the work will be. This molding is making use to the utmost advantage of the span between the thumb and the fingers *en masse*. Most of this molding process is directed by the thumb and the thenar eminence. No jarring or jerking either at the start or finish of the stroke should ever be felt by the patient.

Dr. W. Murrell says that dry rubbing is to be preferred because there is better muscular contraction in consequence of a greater flow of lymph; that electric currents are thus more easily developed in the tissues; and that greater elevation of the temperature of the part ensues; and that the patient is usually grateful if oil has not been used. Dr. Stretch Dowse suggests in cases of painfully stiff joints that equal parts of castor oil and chloroform will help to deaden the pain; he also recommends oil for abdominal massage. Margaret Palmer makes the statement that, until they learn how to use their hands, beginners will find it easier to work with a lubricant; and that later a lubricant should be used only under exceptional circumstances.

On the contrary, my experience teaches me that a student who is beginning to use the hands in various

forms of manipulation has little difficulty in getting accustomed to dry rubbing, and much prefers it, except in cases of excessive scar tissue, or for very emaciated patients, and after the long use of splints. Cod-liver oil or olive oil is sometimes used for young children following a general or local massage if it is desired that some

Fig. 1.—Effleurage of hand, thumb-to-thumb rule observed.

nutrition should be absorbed through the pores of the skin. In cases of this kind the massage has the physiologic effects desired, and the inunction has its nutritive value. Cocoa-butter and lanolin are among the best lubricants, but should be used sparingly. The latter is preferred by some because it is an animal fat.

In the first division of effleurage of the arm the pal-

mar surface of the operator's hand supports the palmar surface of the patient's hand. The operator's working or active hand is then placed finger-tips to finger-tips with those of the patient; if the thumb-to-thumb method is adopted, it is much easier to fit hand to hand. Three or four firm, even strokings on the dorsal surface of the patient's hand are given. In order to

Fig. 2.—Position of hands for effleurage and petrissage of forearm.

conserve time and energy the operator, without changing hands, turns the patient's hand from the prone to the supine position; the supporting hand of the operator then becomes the active hand. The palmar surface is then stroked three or four times in a similar manner. In effleurage of the forearm the patient's hand is in the middle position between pronation and supination.

One hand of the operator is used for the flexor group, while the other hand is supporting the part; then the hands should be reversed for the extensor group. In the second division of the arm the stroke is taken to just beyond the elbow-joint, one hand covering the flexor group, the other hand covering the extensor group. The hands are now in position for effleurage of the arm, which is the third division. In a similar manner the flexor and extensor groups, each in turn, are stroked. Each stroke should be carried to the proximal glands of its division.

Subdivisions of the lower extremity correspond to those of the upper: First, foot; second, leg; third, thigh. In effleurage of the lower extremity the same procedure is used as with the upper extremity. The leg which is being massaged should never hang from the knee-joint, but should be well supported from the hip-joint.

The plantar surface of the foot from the tips of the toes to the heel is stroked with one hand. The other hand takes the stroke on the dorsal surface from the toes to beyond the ankle-joint. The whole palmar surface of the hand should conform to the sole of the foot.

The leg should be grasped with one hand covering the muscles on one side of the crest of the tibia, the other hand grasping the muscles on the other side. In this way one hand covers the anterior tibial group and the peroneal, while the other hand grasps the gastroc-

nemius group, the underlying and posterior tibial group being affected by the pressure from the superficial group. Always, where there are several layers of muscles, especially where the muscles are much developed, the stroking should be deeper, in order to reach the veins and lymphatic vessels which lie nearest the bone.

Fig. 3.—Effleurage of leg.

The third division of the lower extremity is the thigh. Here, because there is a larger surface to cover, it is well to stroke with alternate hands. At first both hands grasp the limb, finger-tips touching in the popliteal space, between inner and outer hamstring muscles. There should be about six alternate hand strokings over the posterior surface of the thigh, bringing the hands over the lateral aspects of the thigh to the anterior sur-

face, where similar action is brought into play, until the whole of the thigh has been thoroughly stroked. This completes the general outline for effleurage of the limbs.

It is well to divide the back into four main divisions, as there is so great an extent of surface. The patient should be in prone lying position on a straight plinth or bed with no pillows under the head. This position cannot be assumed by patients suffering from heart complications or from phthisis, in which a hacking cough is aggravated by this position. In either of these cases, or when it is found inadvisable for the patient to lie flat, the back may be massaged while the patient is in a sitting posture. In general, however, the prone lying position is not at all uncomfortable for the majority of patients.

The first division of the back is from behind the ears, along the slope of the neck muscles, to the tip of the shoulder-girdle. At the beginning of the stroke the forefinger is separated from the other fingers in order to get well behind the ears, and the stroke is carried until all the fingers come in close contact with each other again at the nape of the neck. With the same firm, even pressure, the stroke is then carried to its termination at the acromion process. In this division both hands of the operator start below the inferior angle of the scapulæ and work in opposite directions from the center line, the stroke being repeated several times.

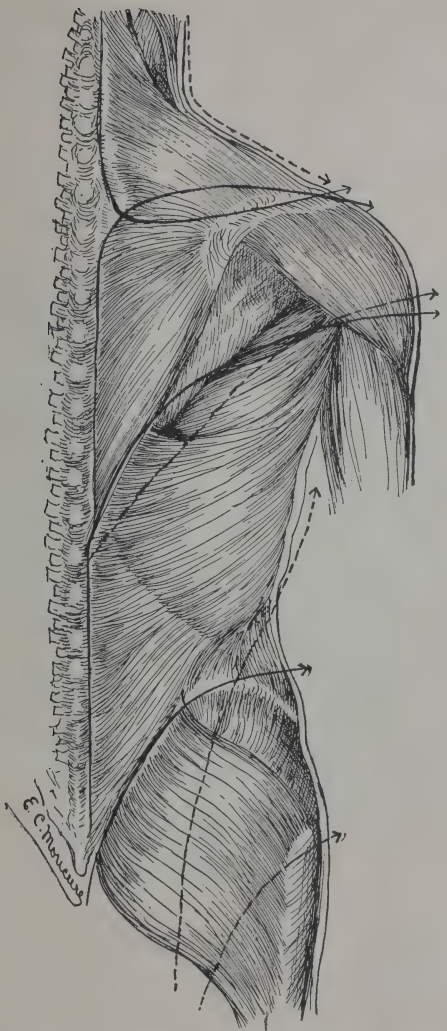


Fig. 4.—Division of the back. Dotted lines outline the fingers and black lines outline the area over which the thumb glides.

In the third division the hands start over the region of the sacrum and both hands stroke upward on corresponding sides until they reach the axilla. They are then brought back, one on each side of the trunk, each describing a circular movement. Care should be taken to cover the whole area with the upward stroke.

Fig. 5.—Effleurage of upper part of back.

The glutei is the last division of the back. Here heavier pressure should be exerted on account of the density of fascia in this region. The operator, starting with one hand on each side of the buttocks, strokes from the apex of the sacrum over the whole of the gluteal muscles, coming back without pressure to the starting-point. When each division of the back has

been effleuraged, it is well to cover the whole surface with long, firm, even strokes from the sacrum to the nape of the neck. As the upper divisions of the back are completed, care should be taken to keep under cover the portion of body that has been massaged.

For effleurage of the chest and abdomen the patient resumes the supine lying position. The head may rest

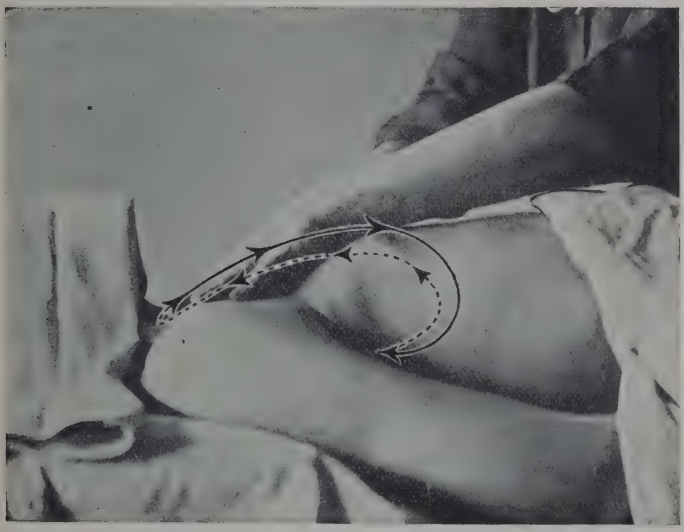


Fig. 6.—Effleurage of chest, first part of stroke.

on a pillow low enough to place no strain on the muscles and blood-vessels of the neck. The hands are placed in much the same position on the anterior surface of the neck as they were on the posterior surface. One hand works on either side from the front of the ear over the front of the neck, the stroke being carried to the tip of

the shoulder-girdle. This is repeated three or four times.

In effleurage of the chest each hand starts the movement with the tips of the fingers on the acromion process. The hands are carried toward the center line of

Fig. 7.—Completion of effleurage stroke for chest muscles, hands now in position for petrissage of same.

the chest and around the breasts, the stroke terminating in the axilla. This is repeated several times.

Effleurage has a reflex action upon the nervous system by affecting the peripheral sensory nerves. It also hastens the blood to the heart by its action upon the cutaneous blood-vessels and lymphatics. Effleurage is

always used before the other forms of manipulation and as a final procedure.

PETRISSAGE

Petrissage, or kneading, may be performed either with the whole of the palmar surface of the hand or by

Fig. 8.—Petrissage of muscles of the arm.

fingers and thumb. For picking up small muscles (as, for example, those of the face) the forefinger and thumb are used. The same divisions of the forearm and arm are used as for effleurage. First the flexors and then the extensors of the forearm are petrissaged. A useful variation of petrissage may be accomplished by the flexors and extensors being grasped by alternate hands,

and a wringing movement being performed. The anterior surfaces of the deltoid region are then petrissaged.

The lower extremity also is divided into three divisions. The foot is petrissaged, special attention being paid to the muscles of the plantar surface. The hand of the operator, making special use of the thenar emi-

Fig. 9.—Petrissage of the shoulder muscles in which a wringing movement is used.

nence, kneads well into the plantar muscles. As the dorsum of the foot is so tendinous, petrissage is supplemented by running frictions between the interossei muscles. The spine of the tibia is used as a guide for the thumb of the operator in petrissage of the leg. On one side of the spine the muscles are kneaded by one hand, and on the other side of the spine by the other.

If the small anterior tibial muscles require special care, finger-and-thumb petrissage is useful, as the muscle group is small and lies snugly against the tibia. In giving petrissage to the quadriceps group the two hands are used as one, the thumb of the right hand lying alongside the forefinger of the left hand, or vice versa. In this way the two hands, as one, pick up the anterior

Fig 10.—Petrissage of calf muscles.

thigh muscles. The adductors and hamstrings are petrissaged by alternate hands.

The back is divided in the same way for petrissage as for effleurage. Each section in turn is petrissaged by a pressure of muscles against the ribs, or, in the lumbar region, upon the abdominal wall. These muscles cannot be picked up as those in the limbs. The whole

of the palmar surface of the hand is brought into play, but not in a molding manner as for the limbs, because the contour of the surface is flat instead of rounded.

The glutei muscles and fascia, being dense, require a much deeper kneading than those in any other region.

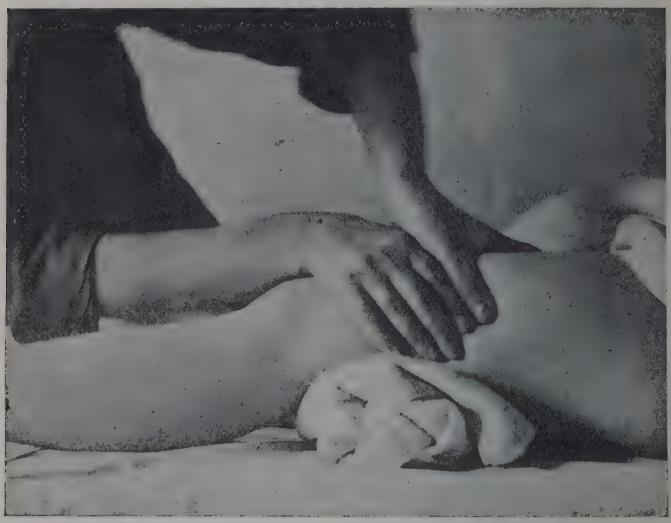


Fig. 11.—Petrissage (two hands as one) over the quadriceps extensor group.

The kneading movement over the glutei is similar to that in kneading dough.

The chest muscles are petrissaged in much the same way as those of the back. In abdominal massage the operator usually assumes a position on the right side of the patient, the arms of the operator being on a level

with the patient's abdomen. Kneading of the abdominal muscles is of two types—transverse and circular. Both hands of the operator are placed side by side with the index-fingers together. From the right side the abdominal muscles are pressed toward the center with the heels of the hands, the fingers pressing from the left side toward the middle line. This transverse kneading is light at first, and the depth and pressure of the movement are gradually increased. The circular kneading immediately follows the transverse without the loss of contact and without interruption. In circular kneading the hands are cupped, the ulnar border of the one starting the movement which is carried on by the finger-tips toward the ulnar border of the other. The movement terminates with the heels of both the hands, and is continued for from three to five minutes.

Petrissage acts upon the deeper blood-vessels, lymphatics, and nerves. It also assists the glandular functions by promoting secretions and excretions. The local temperature is raised and absorption is promoted.

FRICTION

Friction, or circular friction, is that form of manipulation in which the tips of the fingers or the fingers and thumbs are used—more especially around the bony prominences of joint surfaces. Pressure in a circular manner is brought to bear upon the underlying structures. This form of manipulation is extremely useful in

breaking down adhesions and in promoting absorption. Friction should be followed by effleurage in order to send on through the blood-stream the broken-down products of inflammation.

Friction is performed by circular movements with the finger-tips, or with two or three finger-tips, or even with

Fig. 12.—Circular frictions on phalangeal joints upon alternate fingers.

one, according to the amount of surface to be covered. Around joint surfaces pressure is brought to bear upon the underlying structures. In friction of the phalangeal joints the joints of the first and third fingers are manipulated between the finger and thumb of the operator.

In the same way the second and fourth fingers receive friction. If friction is given simultaneously to alternate fingers, one hand of the operator is not in the way of the other. Friction is given around the wrist-joint with two or three fingers and thumb. In the lower extremity the toes and ankle-joint receive similar treatment. In cases in which there is excessive scar

Fig. 13.—Friction around the ankle-joint.

tissue friction is the most useful form of manipulation to loosen it. The effete matter in cases of bruises, if allowed to remain, will become organized and cause thickening of the surrounding tissues. Friction in such cases will dispose of the effusion and help to open up the blood-vessels.

Running frictions are sometimes used to advantage in

a case of recovering sciatica. Over the denser area the thenar eminence is used for the circular frictions, starting over the great sciatic notch where the sciatic nerve emerges from the pelvis. These friction movements are carried down the whole area of the terminal endings of the sciatic nerve.

Friction prevents or breaks down adhesions if tissues are bruised, matted, or thickened, and is especially used to advantage around joint surfaces.

TAPOTEMENT

Tapotement is a series of brisk blows, one following another in rapid succession. It may be performed in four ways: Hacking, clapping, tapping, and beating.

Hacking is the most common form of tapotement. The operator's hands are held with ulnar borders of each ready to strike. The fingers are slightly flexed and parted, and the hands strike alternately. As the blow falls the fingers strike together. They are then separated, and the hand is raised some distance from the patient before the blow is repeated. Hacking is performed so as to strike transversely across the muscle-fibers from one end of the muscle to the other. This causes mechanical contraction of the muscle.

Clapping is done with a cupped hand, the fingers and thumb being slightly flexed and the palmar surface contracted. This form of tapotement is especially useful for covering the entire surface of the back. Clap-

ping is also used over the chest muscles. It has a stimulating effect when used over peripheral vessels and nerves.

Tapping is performed with the fingers cone-shaped, and sharp, brisk tapping movements are applied with the tips to the surface desired. Over the nerve trunks,

Fig. 14.—Hacking longitudinally over the area of intervertebral foramina from which thirty-one pairs of spinal nerves issue.

where they issue from the cord through the intervertebral foramen, this tapping movement may be performed with sufficient force to overcome the density of back muscles and spinous ligaments. This has a stimulating effect upon the nerve centers.

Beating is done with the ulnar border of the closed

hand, as in making a fist. This form of tapotement is used over the gluteal muscles where the fascia is dense.

If tapotement is strong enough in its application the relief of pain is quite marked. This is due to a state of

Fig. 15.—Clapping over the whole of the back with the cupped hand.

fatigue in the nerves brought about by the mechanical stimulus which follows this form of manipulation.

Tapotement excites capillary circulation, has a stimulating or sedative effect upon the nerves, and causes muscular contraction without the will power being brought into play.

VIBRATION

Vibration is performed with several fingers or even with one, and at times the whole palmar surface of the hand is used. A trembling sensation is conveyed by the operator over the most cutaneous part of a nerve; for example, the forefinger is placed over the supra-orbital notch and a vibratory movement is conveyed to the supra-orbital nerve. In cases of neuralgia this vibration will have a benumbing effect which will react in a sedative manner if the vibration is given with sufficient force. Vibration over the abdomen is effected with the whole palmar surface of the hand. This vibration is particularly helpful for its stimulating effect upon the stomach, intestines, and the other abdominal organs.

Vibration stimulates glandular and vascular activity and the organs of digestion. It has a stimulating effect upon the nervous system by its action upon the nerve centers and upon the terminal nerve branches.

CHAPTER II

MOVEMENTS OF JOINTS—ACTIVE (THREE FORMS), PASSIVE

THERAPEUTIC exercise is sometimes spoken of as corrective gymnastics, Swedish remedial exercise, orthopedic exercise, medical exercise, and other synonymous terms. The phrase "therapeutic exercise" seems to cover the subject in rather an inclusive manner and will be used in this text. Body movements and positions, while primarily related to joints and the motor mechanism, also influence other structures and their functions. Exercise may be divided into two classes, active and passive, the first of which is subdivided into three types:

1. Active
   - (*a*) Free
   - (*b*) Assistive
   - (*c*) Resistive
     - Concentric, active resistive, or positive resistive.
     - Eccentric, passive resistive or negative resistive.
2. Passive.

There are three distinct stages in muscle action:

1. Positive action on the part of the working muscles by means of which maximum contraction is reached, and the origins and insertions of the muscles are approximated.

2. Negative action on the part of the working muscles by means of which a lengthening takes place, and the distance between the origins and insertions of the muscles is increased.

3. Static action on the part of the working muscles by means of which the origins and insertions of the muscles are held in constant relationship to each other owing to the continuous slight contraction of the opposing muscle groups.

A simple example of the three different stages is:

1. Flexing the forearm by contracting the biceps group. This is known as positive action of the biceps group.

2. Extending the forearm in which the two ends of the biceps group are separated. This is known as negative action of the biceps group.

3. Maintaining the arm in any constant position so that the origin and insertion of the biceps group remain in their relative positions to one another. This is known as static action of the biceps group.

Good body statics indicate that static action between opposing muscle groups is well balanced.

ACTIVE MOVEMENTS

Free, assistive, and positive resistive exercises come under the general classifications of active movements. An active movement is performed entirely by the voluntary impulse of the person. Voluntary impulses originate

in the cortical motor area of the brain. That is one reason why in the performance of exercises, especially those of distinct remedial value, we want to bring into play the higher centers in order to make the exercise real neuromuscular training. This involves concentrated effort on the part of the person. A great percentage of our normal activities are purely reflex action, such as walking, etc., which, when once acquired, becomes a reflex. Active exercises are most beneficial in the cerebral lesion type of paralysis. This is truly re-educative work of the upper neurones. It is also much used in the treatment of recent fractures for early restoration of function.

Free.—All free exercise falls within the class of active movements. In order to differentiate prescribed exercise from the free movements of every-day life the term "active or voluntary movements" in this text will refer only to carefully localized, graded, and prescribed work free from assistance or resistance. The matter of localization is an important one, it includes fixation and support of the part in order to exercise the desired muscles and the elimination (as far as possible) of positive action in other groups.

Assistive movement is one in which the patient is encouraged to exert as much voluntary movement as the muscle is capable of performing. The operator assists the movement as soon as voluntary nerve impulse is incapable of further movement. If voluntary

movements are under normal, the rendering of assistance will help to stimulate more normal function. In muscle training, assistive movements are of great value. The patient is encouraged to make every possible effort to contract the desired muscle group. Even if there seems to be little or no movement present, the attempt to have the patient voluntarily try to force through an impulse is beneficial. Whether little or a fair amount of movement is present, the operator does not render assistance until every possible effort on the part of the patient is completed. Then the movement is carried by the operator to its fullest possible range of motion.

Assistive exercises require intelligent work on the part of the operator.

For rendering either assistance or resistance, the operator should be guided by an understanding of the joint mechanism and of the neuromuscular action which controls joint movement. Grading of assistance, dosage, fixation, and a knowledge of the laws of gravity are important factors.

Resistive movements are divided into two forms. In the first and most commonly used, there is a concentric or positive contraction of the working muscles; resistance is furnished by an outside party or apparatus. In this form there is a shortening of muscle-fibers against external resistance. Resistance by means of apparatus is not so satisfactory as that supplied by

the human hand with the mind working behind to govern it.

In the second form there is an eccentric or negative contraction of the working muscles; resistance is self-imposed. There is a lengthening of muscle fibers against internal resistance. The second form is not commonly used, but has its place, which will be discussed below.

In any active movement a certain amount of resistance is furnished by the weight of the body and by the opposing muscles. We shall speak of resistive movements, however, as meaning resistance applied by the human hand or by the person himself. Every movement of the limbs takes place through the co-operation of two groups of muscles opposed to each other. The tension of the flexors on one side equals that of the extensors on the opposite side, thus a balance is maintained. By the application of graded resistance to one of the groups, one-half of the tension is exerted on the joint surface, and one muscle group may be temporarily excluded from action. Consequently, intelligent resistive exercises are easier upon the articulating surfaces of an affected joint than either strictly active or passive exercises. All resistive exercises should be graded according to Schwann's law, which is "that the strength of the muscle is reduced in direct proportion to the state of contraction, or to its relative length." In the different phases of muscle action,

therefore, different grades of resistance should be employed. Following Schwann's law of muscle action, in the first part of voluntary muscle contraction the operator exerts little resistance. Gradually the resistance is increased until maximum contraction of the muscle is reached; then less resistance during the last stage of contraction.

A positive resistive exercise is particularly good for strengthening muscle-fibers. It is also useful for the isolation of muscle groups. For example: In an injury near the insertion of the biceps muscle (in which there is muscle spasm if the biceps is brought into negative action) extension of the forearm may be brought about by a positive action of the triceps, resistance being offered by the operator on the back of the forearm. A positive resistive exercise for the triceps practically excludes the biceps from action.

Negative resistive exercise has one outstanding example of its usefulness, and that is, stretching in cases of contracture. At times a definite amount of stretching can be attained if the patient will offer resistance while the operator is attempting to pull in the direction desired for stretching. Forcible stretching should be administered only with extreme care. Passive flexion by means of short see-saw movements should precede any attempt at extension, and the latter should be carried out by means of one continuous pull.

PASSIVE MOVEMENT

A passive movement is one that is performed by an outside person or apparatus, the patient himself endeavoring to relax as much as possible during the movement. The holdings for passive movements will be described in detail below. When movements to joints are given the parts immediately above and below the joints should be so grasped by the operator as to confine all movement to the desired joint or joints. For example: If the metacarpophalangeal joints are to be passively exercised, the hand should be held firmly below the wrist-joint, thus confining the movement to the metacarpophalangeal joints alone. If slight traction is exerted while giving passive movements it will aid the function of the deep lymphatics around the joint. Each movement should be taken to its limit three or four times except in cases of stiff and painful joints. In such cases almost any movement increases irritation and causes spasm in the muscles, so that movements in this type should be confined to within the limit of pain, and the joint should be very carefully moved once only through its arc of motion. All passive movements should be smooth, even, and never jerky at any time.

The holdings for passive movements which usually accompany massage will be described for the individual joints. In giving a general massage each joint movement should be taken to its limit three or four times,

and the part should be supported above and below the joint.

Upper Extremity

Hand.—The phalangeal and metacarpophalangeal joints are hinge-joints, and their anatomic arrangement is such that they may be simultaneously exercised in the following manner: The palmar surface of the hand of the operator covers the dorsal surface of the patient's hand, the fingers of the operator covering those of the patient. The wrist-joint should be supported by the operator. If a condition indicates attention to individual phalanges, the procedure is much the same. The thumb is taken separately, flexed, and extended. The thumb, having a saddle-joint, is also capable of a circumductory motion.

Wrist.—The forearm above the wrist is held by one hand of the operator, the other hand grasping the metacarpal region, giving movements of flexion and extension. A lateral pull each way with slight traction is also given to the wrist-joint.

Elbow.—In order to take the weight off the forearm the patient should be seated or lying with the arm, shoulder, and elbow resting on a table or plinth. The forearm is grasped above the wrist, and flexion and extension movements are given. In order to give pronation and supination the hand of the patient should be held as in shaking hands, elbow being supported. The palmar surface is turned upward in the fully supine position;

Fig. 16.—Flexion in the phalangeal joints.

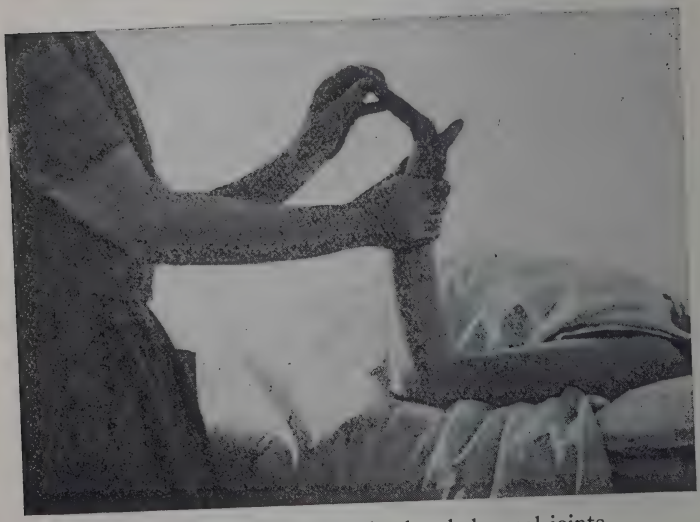


Fig. 17.—Hyperextension in the phalangeal joints.

then the palmar surface is turned downward in the prone position.

Fig. 18.—Flexion in the elbow-joint.

Fig. 19.—Supination of the forearm from the prone position.

Shoulder.—In accordance with the laws of leverage, muscular action is more easily performed if the patient

assumes the lying position. Later, movements can be given in the sitting position for the same series of exercises, either of an active or passive nature. In flexion, the arm is carried in the forward horizontal plane and back to the body line in the same plane to the

Fig. 20.—Horizontal flexion in the shoulder-joint.

extended position. Adduction is then given, followed by abduction, in which the arm is carried to an angle of 90 degrees with the body. If the angle between the arm and the body is more than 90 degrees, the movement is no longer confined to the shoulder-joint, but involves some shoulder-girdle movement. This, taken to its limit, brings the arm into the vertical position, but is not strictly a shoulder-joint movement. For rotation the arm is raised by the operator to the

abducted position. The forearm is flexed, one hand of the operator supporting the elbow-joint, the other one holding the forearm above the wrist-joint. In this manner the head of the humerus is rotated to its limit in the glenoid cavity of the scapula in an inward and outward rotatory movement. Circumductory movements are given with the arm of the patient in much the same position as for axial rotation. The arm is carried in a circular movement, first forward and then backward. Circumduction exercises all of the various muscle groups which control the shoulder-joint action.

Head.—With the patient seated, the head is grasped on each side by the hands of the operator, and is flexed and extended. This action is produced by rocking the head on the concave surfaces of the atlas. Rotation is accomplished by rotating the head on the odontoid peg of the axis. The next movement is circumduction, which involves the anterior, posterior, and lateral muscles of the neck.

Lower Extremity

Foot.—The phalangeal and metatarsophalangeal joints are hinge-joints, corresponding to the distal joints in the upper extremity. For movement of the toes one hand of the operator grasps the ankle-joint, the other hand moves the toes *en masse*, making a full range of flexion and extension.

Ankle.—The ankle is held with one hand above the joint, the other hand grasping the foot, flexion and extension in the ankle-joint is given. For inversion, the foot is held between one or both hands of the operator and turned inward; for eversion, with the same position, the foot is turned outward.

Fig. 21.—Inversion of the foot.

Knee.—When movements to the knee-joint are given the patient should be in a supine lying position. One hand of the operator grasps above the knee-joint, the other holding the heel. Full range of flexion and extension is given in this position. In cases of fibrosis of the

knee-joint the operator has more control in giving forcible flexion if the patient is in the prone lying position (Fig. 22).

Hip.—With the patient in the supine lying position, one hand of the operator grasps the heel of the patient, the other hand being placed in the popliteal space

Fig. 22.—Patient in prone lying position for flexion in the knee-joint if forcible stretching is necessary in cases of fibrosis.

(Fig. 23). As the limb is flexed the hand in the popliteal space is brought forward and placed over the head of the tibia. Full flexion of the thigh upon the trunk is assisted by the pressure of the hand that is over the head of the tibia. As the limb is returned to full extension the hand is slipped back to the popliteal space, into its original position. To get abduction and adduc-

tion of the thigh the knee-joint is fully extended, and the whole limb is moved outward and inward. For rotation of the hip-joint the knee is flexed, and the leg is grasped in the same manner as for flexion and extension. Using the leg as a lever, the head of the femur is fully rotated, outward and inward, in the acetabulum.

Fig. 23.—Hands in position for flexion of the thigh on the trunk (first part of movement).

Circumduction is a combination of all hip-joint movements, each muscle group that controls the hip-joint being brought into play in this movement.

A passive movement, therefore, is one which is performed by the operator while the patient relaxes as much as possible. Passive movements act more particularly upon the blood-vessels and lymphatics in the

Fig. 24.—Flexion of thigh on trunk, hand in popliteal space, slipped over head of tibia to complete the movement.

tissues surrounding the joint, and upon the nerves supplying the joint.

CHAPTER III

SOME PHYSIOLOGIC OBJECTS GAINED BY MASSAGE

MASSAGE is used for its physiologic effects upon the body structures. Each individual case calls for a special procedure of manipulation or for a combination of procedures. The physiologic effect desired is the basis for all prescriptions. For instance, in a case in which adhesions were already formed, effleurage would not be the principal mode of procedure. Deep frictions, however, followed by effleurage in order to supplement the effects produced by friction would be an ideal prescription. Too much emphasis cannot be laid upon the entirely different form of treatment necessary for acute, subacute, and chronic conditions. The following are some physiologic objects gained by massage:

1. The skin and its structures are nourished.

2. The venous and lymphatic flows are increased, and thereby waste products are more easily eliminated from the body.

3. The blood-stream is regulated, and, therefore, a more even temperature of the body is gained.

4. Muscle-fiber is strengthened and made to grow as a result of increased nutrition.

5. The nerves are either stimulated or soothed.

6. The blood is attracted from the deeper tissues to

the surface, and, therefore, internal congestion is relieved.

7. Adhesions are sometimes prevented or, if present, removed.

8. The reabsorption of swelling is hastened, and thickened tissues are frequently reduced.

The Skin and its Structures are Nourished.—The different physiologic effects of massage upon the skin, with its sudoriferous glands, sebaceous glands, and peripheral nerve endings, vary according to the form of manipulation used. For example, the lightest form of effleurage has decidedly a sedative effect upon the sensory nerves, and reflexly affects the motor nerves. The relief of local pain alleviates the strain upon the whole of the nervous system. This is very readily seen in the Championnière method of treatment of recent fractures. Severe muscle spasm, as the result of the lightest form of stroking, so light as to have no mechanical effect, is often surprisingly alleviated. The action is purely reflex. The muscular spasm which follows dislocation of the shoulder-joint is perhaps the most trying condition for the surgeon to overcome. So frequently may this condition be relieved after quiet rhythmic stroking over the affected area that forcible manipulation without an anesthetic has at times been used to advantage by Sir William Bennett in the reduction of recent dislocations. The vasomotor centers are stimulated through the sympathetic system by effleur-

age, petrissage, and tapotement, the effect being the dilatation and relaxation of the walls of the blood-vessels.

The Venous and Lymphatic Flows are Increased, and Thereby Waste Products are More Easily Eliminated from the Body.—Petrissage is the most effective form of manipulation to gain these results. When the patient is thoroughly relaxed the muscles, blood-vessels, and lymphatic spaces throughout the tissues are manipulated in such a way as to hasten the venous blood and the lymph toward the heart. The vessels under treatment are dilated, and thus resistance is lowered. Because of this lessened resistance in the tissues the backward pressure of the arterial blood upon the heart is relieved. The heart, in consequence, is able to contract more readily and so empty its cavities more completely. The exertion of pressure upon the lymphatic vessels and glands aids the absorptive system. Waste products are, therefore, more easily carried to their organs of elimination.

The Blood-stream is Regulated and a More Even Temperature of the Body is Gained.—Experiments and clinical observation have proved that both red and white corpuscles, as well as the amount of hemoglobin, are increased by massage. Massage also causes a change in the distribution of the corpuscles. Many corpuscles which were adherent to the walls of the vessels and which, without external pressure, would have remained

so, are assisted on through the circulation. The heat-producing property, oxyhemoglobin, in the blood-stream is distributed more evenly throughout the body, and thus the temperature of the body is regulated. Muscle-fiber is strengthened and made to grow as a result of increased nutrition. The circulation of the blood is increased in a muscle that is undergoing manipulation. The fresh supply of oxygen and food products that are carried to the tissues by the blood-stream helps to build up and renew the muscle-fibers so that they are increased in size and in strength.

The Nerves are Either Stimulated or Soothed.—In cases of neurasthenia, in which there is a sluggish nerve reaction, there is no doubt that stimulation through motor, sensory, and sympathetic systems will sometimes show excellent results when all else fails. An understanding approach and a cheerful encouraging attitude on the part of the operator should always be borne in mind in dealing with neurasthenic patients. As the mind plays so important a rôle in all such cases the operator must always have in mind the stimulation of the nervous system through each existing channel. Massage given for its sedative effect, in cases in which muscular spasm is pronounced, has already been discussed in the previous paragraphs.

In 460 B. C. Hippocrates, a noted Greek physician, made the following statement in relation to rubbing: "Things that have the same name have not always the

same effect. Rubbing can bind a joint that is too loose and loosen a joint that is too rigid. Rubbing can make flesh or cause flesh to waste." Hippocrates might also have added that rubbing can have a stimulating or a sedative effect upon the nerves. In order to gain these desired effects the operator must exercise both reason and intelligent understanding, two very important factors, if good results are ever to be accomplished in this kind of work.

The treatment for the neurasthenic of the phlegmatic type is a stimulating massage, followed by resistive exercise, progressing, as soon as the patient is able, to take voluntary exercise. If the doctor prescribes it, the patient may be encouraged to participate in outdoor sports, such as golf, tennis, or regular daily walks.

In direct contrast to the phlegmatic type is the overwrought, highly strung nervous type, which is so commonly seen in the cities of the United States of America. Here life not only demands the most in human efficiency, but constantly keeps the nervous tension high, whether it be in professional, commercial, or social life. Even in athletics this tension is marked. It is no small wonder, then, that women, and men too, have not the rugged nervous temperaments of their forefathers. The treatment for this type must be wholly adapted to produce a sedative effect. This consists of quiet stroking, deep kneading, passive exercises, and relaxation, in which the patient is taught to "let down" for a definite period each

day until the tension of the nervous system is at least relieved. One important feature of obtaining results in the treatment of this type lies in the personality of the operator, who should understand the meaning of "mental gymnastics" and the control of the inhibitory centers.

The Blood is Attracted from the Deeper Tissues to the Surface and, Therefore, Internal Congestion is Relieved.—By inducing hyperemia much the same results may be attained through massage as are produced by an application of heat or by any form of counterirritant.

Adhesions Are Sometimes Prevented or Removed.—Prevention is better than cure. For example, in a case in which tendons, fascia, blood-vessels, and ligaments have been bruised and injured, the ideal treatment would be effleurage, which will dispose of the effused products through venous and lymphatic channels, keeping the circulation in the affected area in better condition; and passive and active movements to distal joints, which will prevent the tendon sheaths from adhering. When adhesions have already formed, the treatment should consist of a circular, frictional movement around the part injured, followed by effleurage. The broken-down products of inflammation are thus more readily transferred into the blood-stream.

The Reabsorption of Swelling is Hastened, and Thickened Tissues are Frequently Reduced.—In a case of synovitis, when the acute inflammation has subsided, it is well to aid the absorption of the excessive exudate

into the lymphatic vessels in the proximal area. A free channel should be opened to dispose of the products of inflammation before they have become too firmly organized. Infiltrated tissues, if assisted in this external, mechanical way, will respond very well to early treatment.

In edematous cases, in which tissues have become thickened and induration is present, the balance of play in the interchange of lymph from the capillary walls and the lymph spaces is lost, resulting in an accumulation of lymph in the cellular tissues, which if not early disposed of becomes organized, and making the part feel tough and "doughy" to the touch. Hot packs followed by firm finger frictions around the affected part will help to re-establish normal conditions by disposing of the excess of lymph through the lymphatic vessels.

CHAPTER IV

OUTLINE FOR GENERAL MASSAGE; HEAD MASSAGE; WEIR MITCHELL TREATMENT; GOLDEN RULES FOR MASSAGE

MASSAGE and passive movements furnish a form of exercise for the muscular system that makes relatively light demands upon the nervous system. The removal of waste products of oxidation through the venous and lymphatic channels increases metabolism in the tissues. Decreased resistance in the peripheral vessels is the result of the acceleration of the venous flow and lymph. In addition, there is a large increase in the number of red blood-corpuscles and an exalted heart-beat without a corresponding change in the arterial tension. There is an initial rise both in arterial and venous pressure immediately following massage, but it is of brief duration. A fall of arterial pressure occurs early upon the cessation of massage, and a fall of the venous pressure follows.

It is intended in this chapter to present an outline of a general massage, and suggest approximately the length of time to be bestowed upon each part manipulated, including the movements to joints. In giving the first treatment, however, it is never advisable to use the

full time. This treatment should consist of effleurage and passive movements to each joint, and should not cover more than twenty minutes. In a case in which the patient is nervous, or may be averse to this form of treatment, it is better to start movements to joints during the second or third treatment. By this time the patient should have gained confidence in the operator and in the treatment. If there is a condition requiring more definite treatment in a certain part, more time should be devoted to that part and less to other parts. It is excellent practice for the beginner to attempt to perform the various procedures, including movements to joints, upon the upper and then upon the lower extremity, within a given time. Afterward a general massage within a fifty-minute limit may be attempted.

The patient should be encouraged in deep breathing along with this treatment, as its effect is especially beneficial upon the deeper veins and lymphatics in the thorax. In this way internal massage is promoted, and the blood and lymph are hastened toward the right side of the heart. There is no hard-and-fast rule, but the following table, stating the approximate length of time for the limbs and trunk, is given as an aid to beginners:

Upper limbs	10 minutes
Lower limbs	15 "
Back	10 "
Chest	5 "
Abdomen	5 "

The temperature of the room in which the treatment is to be given should be not less than 65° F. The patient should be in bed and wrapped in a sheet or blanket. There is no need of exposing any part of the body other than that under treatment at the time. If there is any danger of the patient's taking cold, massage may be given under the bedclothes or, at least, under a light-weight covering. If the patient wears a night-gown, each arm should be taken from the sleeve and replaced when treated. A light-weight but warm shawl is useful to cover the upper part of the back while the lower part is being massaged. Although abdominal kneading and vibration are very helpful in cases in which the patient suffers from constipation, abdominal massage, if not specially ordered, may be omitted when giving general massage. Special treatment for constipation by massage and exercise will be discussed in the chapter on Abdominal Conditions in the section on Therapeutic Exercise.

If the treatment is begun with the upper extremity, the fingers and hand are first effleuraged, friction being given around the finger-joints and to the wrist. The thenar and hypothenar eminences are kneaded by finger-and-thumb petrissage, followed by all movements to the joints of the hand and wrist. As described in Chapter I, the forearm should be effleuraged and petrissaged from the position between pronation and supination in order that the flexor and extensor muscle

groups may be grasped separately. The final effleurage of the forearm may be carried to the shoulder-joint. The flexors and extensors of the arm are petrissaged, either singly or together. This is accomplished by the alternate use of the right and left hands of the operator. Kneading and hacking over the muscles of the arm and divergent stroking over the deltoid region complete the manipulation of the upper extremity. The movements of the elbow-joint are flexion, extension, pronation, and supination. The movements in the shoulder-joint are flexion, extension, adduction, abduction, rotation, and circumduction.

The lower extremity is dealt with in much the same manner. Effleurage and petrissage of the foot, friction around the ankle-joint, flexion and extension of the toes, flexion, extension, inversion, and eversion of the ankle-joint, complete the manipulation of the foot.

In effleurage of the leg one hand is used over the anterior tibial and peroneal groups, the other hand stroking the gastrocnemius and posterior tibial groups. The hands are now in position for the kneading of the anterior and posterior groups. Because of the bony prominences of the anterior aspect of the leg tapotement is almost entirely confined to the posterior aspect. Effleurage in every case completes the manipulation of the part.

Effleurage of the quadriceps, adductors, and hamstrings is followed by petrissage. The latter movement

is accomplished by the operator placing the hands side by side, the thumb of the left hand lying alongside of the forefinger of the right hand (Fig. 11). It is possible in this way to cover a larger area of the quadriceps, at the same time exerting more force in giving petrissage.

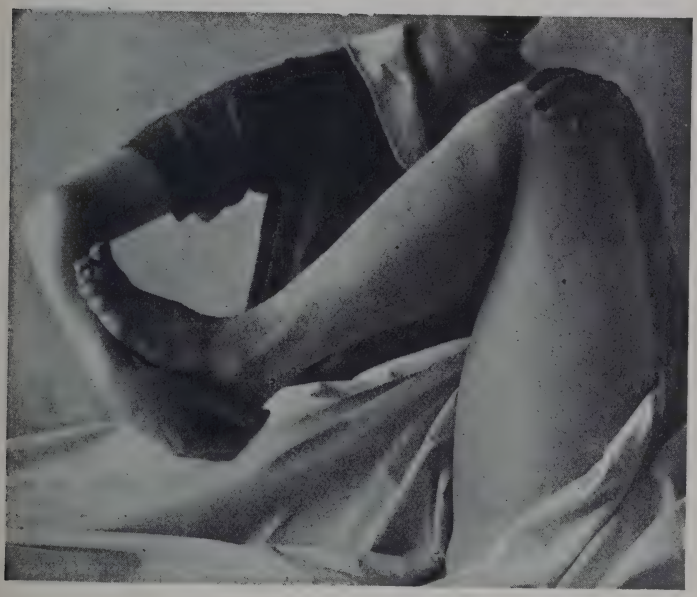


Fig. 25.—Knee pumping.

The adductors and inner and outer hamstrings are petrissaged, followed by alternate stroking and tapotement over the quadriceps femoris group. The movements in the knee-joint are flexion and extension. In cases in which there is poor circulation in the lower extremities better circulation may be established by

knee pumping. In knee pumping the leg is held at right angles to the thigh, the heel being used as a handle and the leg as a lever (Fig. 25). In this position a number of brisk (not jerky) flexion and extension movements are given to the leg. Flexion, extension, abduction, adduction, rotation, and circumduction of the hip complete the massage of the lower extremity.

As described in Chapter I, for the massage of the back the patient should be in the prone lying position. A small pillow placed under the abdomen will help to relax the back muscles. The four divisions of the back are massaged in succession.

After effleurage, petrissage, and tapotement of the first and second divisions of the back are completed, those parts are covered to protect them. The third and fourth divisions receive the same treatment, except that the glutei region, being more dense, gets beating instead of hacking. The cover is now entirely removed and the final procedure of effleurage is enacted, four to six strokes being administered, and each stroke extending the whole distance from the sacrum to the acromion. Tapotement in the form of brisk tapping for its stimulating effect, or light rhythmic hacking for its sedative effect, is used, according to the needs of the individual patient. Cupping the muscles, the hands being used alternately and making longitudinal sweeps each side of the spinal column, contributes the final procedure for the back.

Effleurage and petrissage of the anterior part of the neck and of the chest are next given.

Abdominal massage consists of transverse and circular kneadings, followed by strokings of the colon from the right side up the ascending, across the transverse, and down the descending colon. Vibration, given with the whole of the palmar surface of the hand, has a stimulating effect upon the abdominal organs.

Fig. 26.—Patient in position for abdominal massage with the knees slightly flexed and supported by pillow.

If it is desired that sleep should follow massage it is wise to give abdominal massage early in the treatment. If sleep is the first consideration it is better to omit abdominal massage. Deep abdominal kneading tends to raise the blood-pressure and prevent sleep through accumulated blood in the splanchnic veins being hastened into the systemic circulation.

HEAD MASSAGE

In cases of insomnia or if the patient is suffering from nervous headache, massage of the head is soothing and helps to promote natural sleep. The patient should be seated and the head steadied against the body of the operator, who stands behind the patient. Firm circular frictions with the finger-tips are given, covering the whole surface of the scalp. These frictional movements should have sufficient pressure to move the scalp muscles freely upon the bone. This is followed by a frictional movement, which is accomplished by a span of the radial side of the hand between the thumb and forefinger. The hands grasp the head, one on either side, the fingers and thumbs performing circular movements. The hands follow in consecutive movements from lateral to anterior and posterior positions. Firm circular frictions without pressure, around the mastoid process and over the forehead and temples, will help to relieve local congestion. This should be followed by firm strokings from behind the ears, over the jugular veins, toward the acromioclavicular joints. A hot foot-bath during the treatment, or immediately following it, will assist in drawing the blood from the upper extremity, thus further relieving local congestion.

WEIR MITCHELL TREATMENT

Dr. Weir Mitchell, of Philadelphia, was the originator of a treatment which is known by his name. It consists

of rest, isolation, overfeeding, massage, and electricity. The two latter are used in order to overcome the evil effects that would follow complete rest and overfeeding. The treatment usually lasts from six to twelve weeks and a general massage is given once or twice daily. Letters as well as friends are discouraged at first, and the nurse and masseuse are the only persons that the patient is allowed to see. It is necessary that cheer and discretion accompany the mechanical part of the treatment, as the patient frequently is suffering from overwork or from mental strain. If the patient shows evidences of self-pity, this tendency should be minimized. A case of this kind requires careful handling and understanding. Massage should be gentle at first, and the vigor and length of treatment should be gradually increased. Regular and nourishing meals are given, with warm or cold milk at intervals as prescribed. Massage is usually begun within the first few days of treatment, and lasts about twenty minutes for the first time, but is increased a few minutes at each treatment until a limit of an hour or an hour and a quarter is reached. Because the patient is unable to take exercise, and the liver is overworked, twenty minutes of the time of treatment may be spent to advantage in vigorous abdominal massage, special attention being paid to the liver and stomach. About two hours after breakfast and again between 4 and 5 o'clock in the afternoon are good times of day for this treatment. If the patient

suffers from insomnia, it is recommended that the last treatment begin at 8.30 o'clock, just before the patient retires for the night. Massage on alternate days only, with more active and resistance exercises, is prescribed toward the end of the treatment, to prepare the patient for normal living.

GOLDEN RULES FOR MASSAGE

The students may very profitably give attention to the following counsels, which have been sometimes designated as "golden rules for massage":

1. See that the patient is in as comfortable a position as possible, and that the operator is in the best position to do the work.

2. Always support the part that is being massaged.

3. The operator's muscles should be relaxed as well as those of the patient.

4. The clothing of the operator should allow of perfect freedom and ease of movement; no sleeve should be worn below the elbow.

5. All procedures should be started moderately, increasing both in force and frequency, and should end gradually, as started.

6. Petrissage should be performed with the whole palmar surface of the hand and not with the finger-tips, except where finger-and-thumb petrissage is required to pick up individual muscles or smaller muscle groups.

General Indications for Massage.—All forms of func-

tional inactivities, subacute and chronic inflammations, simple atrophy and hypertrophy of the lymphatic glands are best treated by massage.

Contraindications.—In skin affections (eczema, acne, and all skin eruptions), acute inflammations, tubercular cases, or any disease in which complete rest is necessary massage is contraindicated.

CHAPTER V

VOLKMANN'S CONTRACTURE (ISCHEMIC PARALYSIS); STIFF JOINTS; TORTICOLLIS (WRY NECK); AMPUTATIONS

CERTAIN chronic conditions and their treatment by massage and exercises will be discussed in this chapter. It is easier for the student to commence work on a chronic case. Subacute cases will be discussed in the next chapter, leading the student to the most difficult task of all—the acute. Not until the hands have become deft in treating chronic and subacute conditions, and a knowledge and insight into the pathologic changes have been acquired, should any attempt be made by the student to treat recent sprains and fractures. Until then all treatment should be left to the surgeon. Knowing that he already has his hands full, it is well for the student to study such cases from the beginning, along with the surgeon in charge of the case, in order that the patient may enjoy the benefit of early and judicious treatment.

VOLKMANN'S CONTRACTURE (ISCHEMIC PARALYSIS)

This condition is caused by a constriction of the blood-supply of the forearm. It frequently follows a fracture of the bones of the forearm or a fracture around

Fig. 27.—Volkmann's ischemic paralysis following fracture of the humerus. With the fingers flexed the wrist can be extended.

Fig. 28.—When the fingers are extended, the wrist is flexed. This is characteristic, and is the result of the shortening of the long flexor tendons always occurring in this process.

the elbow-joint. If the splints were bandaged too tightly, binding the soft tissues together, and constricting the blood-vessels, the condition is liable to fol-

low which is known as Volkmann's contracture. If this paralysis is of a severe nature, it means that the median and ulnar nerves may be pinched in with the other constricted tissues. Treatment should consist of hot packs or hot whirlpool baths which, if kept up persistently, will help to soften the parts. Deep petrissage of the forearm and friction around each joint in the hand and forearm will help to break up adhesions. Great care should be taken in administering movements to the joints, as any forcible stretching is liable to damage the joint structures. Exercises should be of an assistive nature if the patient is capable of performing voluntary motion. If no voluntary motion is possible the operator should grasp immediately above and below the individual joints and give to each one passive motion through as wide an arc of motion as possible. A cock-up splint may be applied to overcome the tendency of the flexor muscles to contract. (See Fig. 40.) When this splint is removed for daily treatment, care should be taken to prevent the flexors from further contracting and thus defeating the purpose of the device. In this deformity the wrist is slightly flexed, the proximal phalanges are extended, and the distal phalanges are flexed. Splintage and treatment should aim at extension of the wrist-joint, and to gradual extension of all phalangeal joints, starting with the distal phalanges.

Operation is warranted in severe cases in which outside measures fail to give results after persistent treat-

ment. The operation aims to free constricted tissues and to release impinged nerves. In extreme cases the surgeon may resort to splicing of the flexor tendons. Massage before and after the operation helps to obtain an earlier restoration of function. The type of treatment is similar to that given for chronic cases of fracture.

Some orthopedic surgeons use the individual finger gutter splints. Each finger of the affected hand is passively extended in turn and the finger splint is strapped on in order to maintain extension. The palm and the splinted finger are then bandaged to a flat metal splint. Except in mild cases the hand splint is not applied for a day or two. The wrist is extended a little each day and maintained in gain of extension by temporary massage of the arm and forearm, and finger vibration around any forearm scar is given daily. Hyperextension of the wrist and fingers is maintained until the constricted vessels are opened up. When the splints are removed for daily treatment care should be taken to forcibly stretch the phalangeal joints, one by one, as described above, the gutter splint being replaced as each joint is stretched. The wrist should receive the same care and attention.

Contracture of the palmar fascia is known as Dupuytren's contracture. In this condition the patient is unable to extend the fingers. An operation is performed to dissect the fibrous scar and release the flexor

tendons. The hand is usually bandaged to a splint following operation after the third day for about two weeks; the splint is removed daily for massage of the hand and voluntary motions of the fingers. If there is a tendency for the tissues to retract after two weeks' time, a small splint may be strapped on and the fingers slightly hyperextended.

STIFF JOINTS

If joints are completely immobilized for a considerable length of time certain changes in the joint structures take place. Accompanying these changes there most likely will be thickening of the capsule, ligamentous adhesions, disturbance of the normal synovial secretion, and degeneration of the muscles controlling the joint movement. It should be remembered that absorption of the exudate takes place more readily at the time when the part is functioning than when the part is at rest. In order to intelligently give physiotherapy treatment the operator should know whether the limitation of motion is due to:

1. Retraction of muscles and of soft tissues.
2. Shortening as the result of scar tissue.
3. From fibrosis or periarticular adhesions.
4. From some mechanical obstruction.
5. From bony ankylosis of the joint itself.

To have the patient entirely relaxed after the administration of an anesthetic is at times the only

sure method to determine to which class the case belongs.

If from 10 to 30 degrees of increased movement in the joint is noted after the first or second treatment of heat and massage, this will help the surgeon to diagnose the case. *x*-Ray pictures show whether actual changes have taken place in the joint surfaces, and if so, the extent of the changes, or whether there is some mechanical obstruction present which would permanently interfere with the restoration of normal motion.

Treatment, Class I.—For retraction of soft tissues heat may be applied in a number of ways. If diathermy is used the electrodes should be placed one above and one below the joint. From 500 to 800 milliamperes of the d'Arsonval type of high potential current is used for twenty-five or thirty minutes. For hot packs it is well to use strips of desired width to cover the part comfortably. These strips should be of heavy flannel and of several thicknesses. These may be placed in the center of a bath towel, which should be immersed in boiling water except for the ends of the towel, which are used as handles while the pack is being tightly wrung out. The flannel is placed around the joint just as hot as can be borne. The moist heat should be allowed to penetrate. As it is necessary to shut out the air the flannel should be well covered and a hot-water bottle may be placed outside the covering to help to retain the heat. A second pack should be prepared to re-

place the first before the former is allowed to feel cool to the patient. If baking is preferred, the part is exposed to dry heat for about fifteen minutes, or until the skin registers a good reaction. Heat in any form helps to soften the tissues and prepares the way for kneading of all the muscles and firm stroking of the limb. Following massage of the muscles the patient is encouraged to try and move the joint, the operator assisting the movement. If the patient is able to get a fair amount of voluntary motion, but is limited in range, the operator may gently stretch still farther in the line of voluntary motion after the patient has done his utmost. As a mark of progression resistance may be added to voluntary motion.

Treatment, Class II.—For shortening, owing to scar tissue, the introduction of sodium chloride into the part is used for its softening effect. Two well-padded metal electrodes are used. The negative electrode is soaked in a 2 per cent. solution of sodium chloride and the positive is soaked in pure water. The negative electrode is placed over the scar and the other one is bandaged opposite to it on the limb. Deep kneading of the muscles and circular frictions around the edges of the scar should be followed immediately by firm stroking. The softening of the scar tissue and of the muscles makes it possible to gain a little from passive stretching. The limb should be supported by the operator, one hand holding above and one below the joint, and the

motion to gain flexion should be given in a see-saw manner, while for extension one long, even, continuous pull should be exerted. The short see-saw motions toward flexion should always precede any pull in the line of extension.

Treatment, Class III.—For breaking down fibrous adhesions around the capsule an application of diathermy for twenty-five or thirty minutes will make it easier for the operator to get results from massage of the muscles. Deep kneading of the entire limb and stroking should be given for several days before any stretching to the joint is considered. Any forcible stretching before the muscles are in a well-nourished condition may rupture the muscle-fibers. Passive stretching, as in the preceding class, should be given only when the muscles are in good condition.

Treatment, Class IV.—If a mechanical obstruction is present operative methods to remove the obstruction should precede massage and stretching, as little or nothing can be expected of physiotherapy treatment alone. After the obstruction has been removed the application of heat, massage, and exercises may be carried out similar to that prescribed in Class I.

Treatment, Class V.—If there is a true bony ankylosis of the joint, physiotherapy treatment to gain mobility is quite useless. The only hope in operative methods is to make a new joint (arthroplastic operation). This operation necessitates a long convalescing period. It

is not considered except in certain joints, and then rather conservatively practised, as the end-results are not always as satisfactory as expected.

To sum up, operative methods in cases of stiff joints, except when bony anklyosis exists, are not as commonly used as formerly. Physiotherapy measures have been known to give excellent results if intelligently carried out. Sir William Bennett, of London, says that the knee-joint answers particularly well for the application of a $2\frac{1}{2}$-inch rubber bandage to bring about a general edema below the bandage (passive hyperemia). He speaks of a most inveterate case of recurrent stiffness after successive breakings down, showing steady decrease of recurrence and finally complete recovery following this form of treatment. Hyperemia may be of two kinds, either the pressure bandage that shuts off venous flow, or the more restricted pressure that blocks also the arterial circulation. If no pain is present the latter may be used; if there is pain the blocking only of the venous circulation is more comfortable and effective.

Stretching of a joint is liable to be accompanied by a certain degree of pain. If pain persists for several hours following the stretching it usually implies irritation in the joint which is an indication that the stretching should be discontinued. Violent stretching at any time is contraindicated. Too much emphasis cannot be laid upon preparing the muscles by heat and massage

before any stretching to a joint is given, and a certain degree of flexion should be gained before extension is attempted. Assistive movements should be considered in preference to passive movements, although, if the way is well prepared, careful passive stretching has a useful place. Assistive movements may be used as a forerunner to active movements. Carefully graded resistance, especially positive resistance movements (see Chapter II, Part I), are particularly good for strengthening the muscle-fibers. Resistance offered by means of apparatus is not good for recovering muscles, as it keeps the muscle in a constant state of contraction, and is liable to spoil normal muscle co-ordination.

TORTICOLLIS, OR WRY NECK

This is a condition in which the head is flexed to one side, the face rotated to the opposite side, and the chin raised. There is a shortening or constant spasm of the sternocleidomastoid muscle on one side of the neck, and a stretching of the same muscle on the opposite side. Other muscles involved are the splenius capitis, levator angulæ scapulæ, and the trapezius. The condition is either congenital or acquired. In the former instance little can be expected from manipulation or exercise. An operation is sometimes resorted to, after which the neck is put in a plaster cast. Manipulation and exercise are beneficial after the cast is removed. In the acquired type, massage and electric treatment may be used to

advantage. Effleurage is applied over the anterior and posterior muscles of the neck and to the upper muscles of the back. Finger-and-thumb petrissage is given to all the neck muscles, and a thorough kneading of all the muscles of the neck and the upper part of the back. Tapotement in the form of hacking is used over the

Fig. 29.—Torticollis, showing relaxed muscles on the left side of the face and neck.

stretched sternomastoid muscle in order mechanically to contract the muscle-fibers, but it is omitted entirely on the contracted side.

The exercise should consist of flexion and extension of the head, lateral bending toward the stretched side, and rotation of the head toward the contracted side,

thus stretching the contracted sternomastoid muscle. Positive-resistive exercises are given, in which the head is voluntarily rotated toward the contracted side, graded resistance being offered by the operator. The head is brought back from the contracted side to the middle position by the operator at the same time the patient endeavors to hold the head toward the contracted side. This insures a further stretching of the sternomastoid muscle.

After the massage an application of electricity for about ten minutes in the form of a slow sinusoidal current is helpful in further contracting the overstretched muscles.

An ideal way of getting contractions on the relaxed side is by using the Morse wave-generator machine. One electrode is placed over the origin of the sternomastoid, and the other one over the insertion of the same muscle. Rhythmic contractions of the relaxed muscles can also be obtained by using the Bristow coil apparatus or a slow sinusoidal of the direct current.

AMPUTATIONS

A fair percentage of amputation cases are seen each year as a result of industrial accident injuries.

Even before the sinus is healed, daily massage of the limb may be started. Effleurage and kneading of all the muscles is given, followed by passive and positive resistance movements. Scar tissue is treated by vibratory

friction. The fingers of the operator make circular vibratory movements around the lip of the scar, always working toward its center (Fig. 30). Twenty minutes of diathermy, using 300 to 600 milliamperes of the D'Arsonval current applied above and below the scar, and followed by the application of a 2 per cent. solution of sodium chloride applied on the negative electrode of the direct current, using from 8 to 15 milliamperes, will help to soften scar tissue.

Fig. 30.—Amputation scar. A finger vibratory movement is used around the lip of the scar, always working toward the center.

Forcible stretchings are given to the muscles in which contractures are likely to develop. These are usually the flexors and the pronators in the forearm, the adductors and flexors in the arm. In the lower extremity in high amputations tendencies to flexion and abduction deformity should be guarded against as early as possible. All stretching should, therefore, be given with the idea of overcoming these tendencies. After treatment the redundant tissue at the extremity of the stump should be bandaged firmly with a bias flannel bandage in

order to aid absorption and to prepare the stump for the fitting of the artificial limb.

Pressure exercises, from four to six times a day, should be encouraged. The patient is at first directed to press the end of the bandaged stump against a soft pillow, gradually using firmer and harder objects. In this way the stump is toughened and is prepared to act as an end-bearing surface. Perseverance on the part of the patient is the principal factor in the process of re-education after the artificial limb is fitted.

CHAPTER VI

SYNOVITIS; BURSITIS; TENOSYNOVITIS; LOW BACK CONDITIONS; VARICOSE VEINS; PHLEBITIS, AND ARTHRITIS

THE subacute stage of certain pathologic conditions will respond much more readily if massage and electricity are started before the chronic stage is reached. This chapter will deal with cases of the subacute type, in which treatment by means of massage and electricity is employed as soon as the inflammation has subsided.

SYNOVITIS

Synovitis is an inflammation of a synovial membrane. Synovial membrane covers the inner surface of the capsular ligaments and is reflected from it a little way upon the articulating surfaces and lubricates the joint. The synovial membrane of the knee is extensive; it lines the joint capsule and extends from under the quadriceps tendon to the insertion of the quadriceps muscle group. The crucial ligaments and the semilunar cartilages are surrounded by synovial membrane. There are also numerous superficial and deep bursæ between the muscles and tendons of the knee-joint. Any injury or fracture near the knee-joint may be the cause of synovitis. Following synovitis there is usually a marked atrophy in the muscles surrounding the joint, and, if

measurements of the circumference of the lower part of the affected thigh are taken, they will show a considerable decrease in comparison with the normal.

Fig. 31.—Synovitis: Squeezing and pressing above and below the joint capsule will aid absorption of fluid in a subacute condition.

The treatment for any subacute synovitis is similar to that described below for bursitis.

BURSITIS

Bursitis is inflammation of the bursa, which is a little pouch or sac of fibrous tissue lined with synovial fluid. These small pouches are placed between parts which freely move upon each other. They act as lubricating buffers and prevent friction. Bursæ are found between two muscles, tendon and muscle, tendon and bone, skin and bone. In any place where there are

bursæ, bursitis may result from injury, direct or indirect, from infection, or fracture of adjacent bones. There are certain bursæ which are more subject to injury than others, the most common being the subdeltoid. The treatment for bursitis of any part is carried out in much the same way as that of the subdeltoid bursæ, which will be described below.

The subdeltoid bursa lies directly below the acromion process of the scapula. It is frequently exposed to injury. In raising the arm in the abducted and upright position the great tuberosity of the humerus glides under the acromion process, the subdeltoid bursa acting as a buffer. A fracture or contusion at or near the great tuberosity or the acromion process, a dislocation of the shoulder, or a direct blow is usually followed by a subdeltoid bursitis, or there may be an insidious cause, as auto-intoxication. In any traumatic type there may be a rupture of the supraspinatous muscle which has its insertion at the head of the humerus, immediately behind the greater tuberosity. Spasmodic contraction of the shoulder muscles is not at all uncommon following a shoulder injury accompanied by pain at or near the insertion of the deltoid muscle. This is spoken of as referred pain.

Massage of the shoulder muscles preceded by some form of heat may be applied early, but no manipulation is given over the region of the bursa. Sometimes the pressure of a hot-water bag strapped over the shoulder

is of advantage because of its sedative effect, and for its help in promoting absorption of the exudate. Voluntary motion is encouraged and assistance rendered as soon as the acute pain has subsided. Resistive exercises are substituted for assistive as the condition improves. The exercises are best given in the following order: flexion, extension, and abduction.

Dr. Rowley Bristow reports good results in such cases by the use of his machine. The Bristow coil apparatus is used for a few minutes over the different muscle groups. Each group is given one or two minutes of rhythmic contraction. A joint bound by adhesions should receive more vigorous massage from the start, and forcible stretchings should be used instead of assistive exercises. Active exercises, such as creeping up the wall and the swinging of 1-pound Indian clubs, should follow the forcible stretching. In the first exercise the patient stands sideways near the wall, with the affected arm about $1\frac{1}{2}$ feet from the wall. The fingers creep slowly up until the limit in creeping is reached. The patient is encouraged to continue this exercise each day, attempting to reach higher. Indian club swinging should be practised daily for several minutes, beginning with small circles, and later advancing to the execution of large circles, using both arms. These exercises are excellent for helping to restore freedom of movement in the shoulder-joint. If the bursæ are calcified the treatment necessarily is

of longer duration. The arm is frequently put up in an airplane splint so that all weight is taken from the affected part. Care should be taken when the splint is removed that the arm is supported in abduction during the time of treatment.

Prepatellar bursitis is treated in much the same manner as subdeltoid bursitis. Heat in any form, massage to the muscles above and below the joint, two minutes each of the Bristow coil rhythmic contractions to the vasti muscles, and the rectus femorus and the fascia lata, followed by assistive and later resistive exercises to the knee-joint, when all pain has disappeared, will help to restore the function of the joint. In certain cases the physician in charge recommends building up the shoe on the inner side $\frac{3}{16}$ to $\frac{1}{4}$ inch.

Chronic irritation of the internal semilunar cartilage.

A displacement of the semilunar cartilage not infrequently follows a sudden twist of the lower leg. Massage of the muscles controlling the joint, especially those above the knee, will help to restore normal muscle tone. Criss-cross strapping with strips of adhesive tape about 1 inch in width and 6 inches in length placed diagonally on the inner side of the knee and overlapping each other will help to support the joint until the muscles become stronger and are able to retain the cartilage in position. Removal of the semilunar cartilage by operation is at times advisable. Kneading of the muscles above and below the joint should be commenced as

soon as the surgeon deems it advisable after the operation. Later, carefully graded resistive exercises should be added in order to strengthen the muscles controlling joint movement.

TENOSYNOVITIS

Tenosynovitis is an inflammation of a tendon and its sheath. It is not unusual to find an inflammation in the foot behind the heel. The usual causes are strain of the tendon or undue pressure of the shoe. If it is from pressure of the shoe, this must be entirely relieved. A thick piece of felt, with a hole cut in the center and applied to the inflamed part of the heel, will act as a protection from the pressure of the shoe, the pad being strapped by means of narrow criss-cross strips of adhesive tape to the heel. The treatment, after the inflammation has subsided, is massage of the muscles of the foot and leg followed by passive movements, and later positive resistance exercises of the ankle-joint to strengthen the muscles.

LOW BACK CONDITIONS

Of late years, especially, there have been many theories expounded and discussed regarding low back conditions. It is generally acknowledged that whatever the etiology may be, a good deal of back pain and disability is the result of reflex spasm of the low back muscles. Two of the most common causes of low back

injuries are: (1) a sudden strain of the lumbar muscles placing excessive strain on the lumbosacral and sacroiliac region, (2) a direct blow or fall in which the lumbar spine suffers from a severe stretching or wrenching. Ligaments are not meant to support structures, but they serve to take up emergency strains. The muscles are the chief walls of defence, and if they are not functioning normally, undue strain is necessarily placed upon the underlying ligaments. In the first type of injury mentioned the patient frequently is in the stooped forward flexed position, the lower back muscles being relaxed. An injury in this specific area may be caused by a sudden and violent exertion at the moment when the muscles are "off guard." Under such circumstances an undue strain is placed upon the ligaments of the low back. The lifting of a heavy weight while the back muscles are relaxed may also be the cause of a similar condition. In the second type of injury the patient may have suffered from a direct blow, or wrench, or twist, or fall, occurring when the distance to be stepped downward was undergaged. At this time also the muscles of the low back have been taken "off guard," with the same harmful effect upon the ligaments. If the injury is severe, the spine itself may be dislocated or fractured, or there may be a tearing of the lower back ligaments or the aponeurotic structures of the same region. The treatment if spinal structural damage occurs is entirely in the surgeon's hands. In every

type, except fracture or dislocation, the treatment is much the same, first, heat for its sedative effect, along with rest, relieving the part from weight bearing during the repair period. This should be followed, as early as the doctor will allow, by massage of the muscles of the back and thighs, and gentle passive movements to the hip-joint. The patient may be taught to grasp the passively flexed thigh with the hands, clasping it above the knee, and gently rocking the limb upon the abdomen several times. At first this exercise should be taken one limb at a time, and later together.

In a spine in which a pathologic change already exists, as in an old tuberculosis or arthritis, the prognosis and treatment differ considerably. Rest is prescribed, with support by means of a brace which takes off all possible strain from the affected joints. In some cases an operation is performed to insure bony ankylosis of the unstable joint. Massage of the muscles of the back before and following the operation will help the restoration of function by keeping the muscles in better condition.

There is another type of weak back in which there exists some congenital anomaly, such as impinging spinous processes, impinging transverse processes on the ilium, abnormal articular facets at the sacral junction. The various congenital anomalies not infrequently constitute the potential weak back type, although until a history of excessive strain of the back, the person may

suffer neither pain nor disability. The *x*-ray picture is helpful in determining the type of strain, enabling the treatment to be carried out more intelligently. A most common type of potentially weak back and one that is not liable to be recognized is that which presents the sharp angle lordosis at the lumbosacral junction. There is freedom in the forward bending position, but restriction in the backward bending position, and at times even pain in backward bending. An increased lumbar curve usually signifies an increase in the obliquity of the pelvic girdle. (See Fig. 69.) This increase of the obliquity of the pelvis places a strain upon the lumbosacral and sacro-iliac joints and their supporting structures, with possible interference of the normal function of the organs in the abdominal and pelvic cavities and possible abdominal muscle relaxation. Another troublesome type of weak back is the one in which there is a relaxed condition of the muscles. (See Fig. 71.)

Irrespective of the case, whether it be any of the above mentioned—the sudden sharp injury, a blow or fall or twist with the low back muscles relaxed, or a history of some anatomic predisposing factor, or the one with relaxed back muscles—the following prescription will answer: The patient should be taught to stand, sit, and walk while holding the body in such a way that weight-bearing strain on the low back is relieved. According to the severity of the case, the doctor

in charge will prescribe the amount of absolute rest preceding treatment. During this period, if pain is persistent, heat in any form will help to ease the pain by relaxing the muscles. Posture training is started after the rest period, or at once if no such period is indicated, and may be given as follows (see Fig. 73):

1. The patient is asked to raise the chest, and then advised to carry it as high as possible at all times. This raises the viscera and relieves any strain of sagging of the viscera upon the abdominal muscles.

2. The patient is asked to stretch up the crown of the head ("tall stretch") without allowing the chin to tilt forward. The body weight also should be carried well forward on the balls of the feet. The raising of the chest must be accompanied by a posterior stretching up on the crown of the head. It is the conjoint anterior and posterior uplift of the trunk that places the head in good alignment with the trunk and places the upper part of the trunk in good alignment with the pelvic girdle. After the well-balanced body position has been achieved, but before it can be maintained with ease, breathing exercises and training of the low back and abdominal muscles follow. To start teaching exercises, it is usually easier to have the patient lie down with the knees partially flexed so that the abdominal muscles are relaxed. He is then instructed to take long deep breaths, the ribs being well expanded as the diaphragm is lowered. The abdominal muscles

naturally slightly expand during inhalation and fall during exhalation, at which time the dome-shaped diaphragm muscle returns to its normal position. Regular inhalations and exhalations with the fullest possible excursion of the diaphragm will exercise this muscle, and the result attained is an increase of the costal angle. The intake of oxygen will be increased in proportion to the expansion of the thoracic cavity. To train the low back muscles, it is well to have the patient lie down on the back on a level and unyielding surface, and have him flatten the lumbar spine against the floor, making sure that the upper part of the trunk and the legs are kept flat. After this exercise is thoroughly understood, and the position of the lumbar flattening can be taken without great effort, leg exercises may be given from the supine lying position, such as alternate knee bending and lowering, keeping the lumbar spine flat throughout the exercise. This will help to strengthen the lower back, abdominal, and leg muscles. The abdominal muscles next receive special attention. A simple exercise is to have the patient rise from a lying to a sitting position, the head coming up to an erect position with the trunk and not before it, and the feet being held firmly by the instructor (see Fig. 76). To make this exercise harder, from the lying position, raise the center of gravity by having the patient place the hands behind the neck, and rise in the same manner as described above. From the supine lying position,

alternate straight leg raising, returning each leg by count of 5 or 10 to the floor calls into play very forcibly the iliopsoas muscle. This muscle lies beneath the lower portion of the abdominal muscles and assists them. Another abdominal and leg exercise is one in which the patient lies flat on the back with the hands behind the neck. From this position both knees are slowly flexed. Then the thighs are flexed on the abdomen as far as possible. This position should be held from 5 to 10 counts, and then slowly the thighs and legs are extended, the legs slowly returning to their original position. The pelvic girdle should be maintained in as stationary a position as possible throughout the exercise. Single leg raisings should be well practised before any double leg exercises are commenced.

Should the diagnosis be actual neuritis of the sciatic nerve, which is pain along the course of the sciatic nerve, entire rest at first with heat and relaxation of the part is the treatment in the acute stage. The thigh should be packed around with hot-water bottles and cushions, both the knees and the hips being slightly flexed. Manipulation of the muscles may be commenced after the pain has subsided. The entire limb is liable to feel stiff and sensitive following an acute attack. Following the acute period massage of the muscles of the foot, leg, thigh, and buttocks should be preceded by heat in any form, care being taken while manipulating to avoid all sensitive spots at first. Grad-

ually, as the condition improves, the whole region may be kneaded without causing pain. After the pain and sensitiveness have disappeared, usually several days at least should elapse before passive movements are given to the hip-joint. Sciatic stretching is helpful if

Fig. 32.—Stretching of the sciatic nerve.

administered with the greatest care, and should be given only at the later stage and in the following manner: The patient lies on the back and slowly raises the extended leg as high as possible without causing pain. From this position the foot is grasped by the operator and slowly and carefully dorsiflexed, the knee being

kept in the fully extended position throughout the exercise (Fig. 32).

If the pain is in the lumbar region, and the diagnosis is lumbago, apply heat in any convenient form to help to overcome the muscle spasm. After the acute pain has subsided it is well to start massage of the lower back. Muscle spasm leaves a tense condition in the affected area. Massage will help to restore muscle tone.

VARICOSE VEINS

In these cases the walls of the veins are distended and the valves become unable to accomplish their work, so that regurgitation of the blood occurs in the veins. At times the veins become so overgorged that they look like knotted purple cords. All constriction by garters should be relieved. The patient should endeavor to rest the lower extremities as much as possible on an inclined plane, for this helps the venous circulation. When the acute inflammation has subsided, and then only with the greatest care, light stroking should be administered. No pressure is exerted over the beaded veins, but the collateral circulation should be encouraged. Kneading of the thigh opens up the veins and lymphatics in the proximal region. Light stroking below the knee, with very careful knee pumping (see Fig. 25), should follow. The limb should be well raised during the treatment, and the patient should always rest for at least twenty minutes after the treatment.

A firm, even bandage will act as a steady pressure on the walls of the peripheral veins. The "Ace" or "Benda" bandage gives good elastic support, or this may be substituted by a fitted elastic stocking. An individual suffering from severe varicosed veins should be encouraged to rest daily, with the leg raised above the level of the hips.

PHLEBITIS

Phlebitis is an inflamed condition of a vein which may follow as a result of typhoid fever, pneumonia, or following any abdominal operation. At times phlebitis follows childbirth. It is commonly associated with thrombosis. Puerperal sepsis may result in thrombophlebitis of the iliac and femoral veins. The danger in a case of the latter is in dislodging the thrombus. The greatest care should be taken that no pressure is exercised over the area of the large veins of the thigh. In a case of phlegmasia alba dolens following childbirth no massage should be commenced until at least two months after the acute stage; then only strokings of the gentlest nature should be given, and when the muscles of the patient are relaxed. Very quiet passive movements to the ankle- and knee-joints follow manipulation. The technic in such cases, accompanied with the knowledge of microscopic and pathologic changes in the veins, should be understood before such delicate work is attempted; otherwise much damage may be wrought.

ARTHRITIS

Arthritis has been the subject of much study and research by the medical profession during the last twenty years. Perhaps the most important feature of this research is that arthritis has been divided into various classifications. Authorities differ in their classifications, but practically all agree that a thorough search should be made in each case to discover the etiology in order to deal primarily with the causative factors rather than with the symptoms produced by them. Treatment or removal of the cause, if possible, may be advantageously followed by physiotherapeutic measures. An early search for the cause accompanied by judicious treatment may prevent some of the most prevalent sequelæ of this disease; for example, stiff joints, contractures, etc. Various types of arthritis will be discussed below and their treatment by physiotherapy. The object of treatment is to prevent the formation of adhesions following long immobilization of the part.

First there is the *toxic* or *infectious* type of arthritis. The infection may be from any infectious origin. The different pyogenic infections are common. *x*-Ray findings in the chronic infectious type show a destruction of the articulating surfaces with loss of the natural contour of the joint (Fig. 33). It is generally considered that there is absorption occurring from some foci of infection, the most common being the teeth, tonsils or intestines, although the cause may be so

insidious that after thorough investigation it is still a debatable question. The symptoms may be acute or subacute at the onset of the trouble.

Fig. 33.—Infectious arthritis. Destructive process of articular cartilage and a loss of the clear outline of the joint surfaces in all the metacarpophalangeal joints.

Physiotherapy treatment should be started early following an acute attack, instead of waiting until the condition becomes chronic and changes in the joint

structures occur. If pain is present, a sedative and softening effect may be produced by placing the part in a warm bath in which the positive elctrode of a galvanic current is immersed and having a well-moistened negative or indifferent electrode bound to an adjacent part of the body that is not under water. This treatment should last about twenty minutes. Hot packs (made from two or three strips of flannel which, after being soaked in boiling water, are thoroughly wrung out within a heavy towel) placed around the joint also have a sedative effect, and bring about a flushing of the part. Kneading and stroking above and below the joint should be continued for several days before any movement is attempted in the joint, no pressure at any time should be borne upon the affected joint or joints. The greatest care should be observed at the time assistive or passive movements are commenced. Any evidence of lasting pain following movements of the joints indicates that the latter must be postponed and the heat and massage continued. The length and severity of the attack must determine when to start movements in the joints. It is best to move each joint once only through its arc of motion until all fear of joint reaction is past. Later gentle resistance may be added to active movements.

Second, the *atrophic* arthritis is considered by some to be the result of some neurotrophic disturbance. *x*-Ray findings confirm the theory of a lack or an excess

of calcium deposit, showing a thinning of the bone ends with occasional spindle-like formation (Fig. 34), while in others there is a more dense appearance than that

Fig. 34.—Atrophic arthritis. Degenerative process of bone ends shown by marked rarified area at each of the metacarpophalangeal joints.

of normal bone. There may be pain and deformity present. The patient sometimes complains of inability to use the joint owing to the flabby condition of the

surrounding muscles. The joint may be tender to touch and a slight swelling as of bone, not of the soft tissues, be present. The small joints are frequently affected, such as the facets of the cervical spine. This type of arthritis is rarely found in the hip- or shoulder-joints, but more often in the sacro-iliac and scapuloclavicular joints. The atrophic type is considered a nutritional disease with vasomotor disturbances, therefore the blood-vessels may be affected, resulting in poor circulation of the part. The skin is often times parchment-like.

The treatment should aim to build up general body tone. Deep breathing and posture training are often beneficial. Heat to the affected part will cause a flushing which should be followed by a kneading and stroking of the muscles and gentle friction around the joint. The fear of stirring up inflammation from movements of the joint as in the preceding type may be disregarded. Active and resistive exercises will help to strengthen the muscles. This type of arthritis is more frequently found in people of the light skeletal type.

Third, the *hypertrophic arthritis*, osteo-arthritis, or arthritis deformans are all terms commonly used in this form of arthritis. Although the etiology is much discussed, most authorities agree that traumatism may play an important part not necessarily by direct blow, but the long-continued constant abuse of certain joints may result in hypertrophic arthritis. The patient is

usually beyond forty years of age. The onset is insidious and oftentimes painless. It is not infrequently found in the low back, knees, large joint of the great toe, and in the terminal phalanges, but is seldom found in the ankle-joints. People of the heavy type are more apt

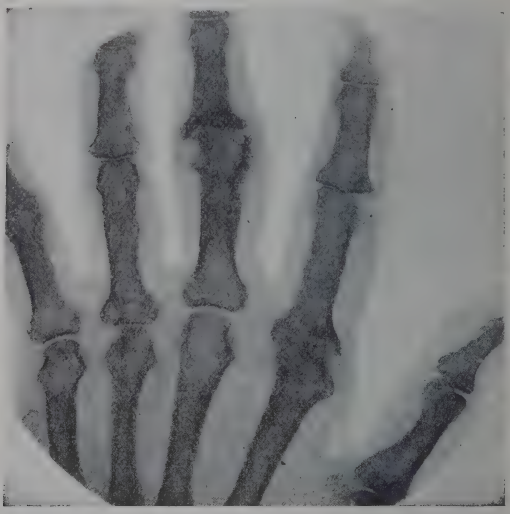


Fig. 35.—Hypertrophic arthritis. Spurs of bone, erosion of synovial membrane, and adhesions of the index-finger in the metacarpophalangeal joint and in the second phalanx of the second finger.

to show symptoms of the hypertrophic type. Those who are on their feet a great deal, especially those who have marked faulty posture, are apt to develop arthritis of the knee-joints, because the bodily mechanics are disturbed and the body weight is improperly distributed on the bearing surfaces of the knee-joint. *x*-Ray

findings show bony spurs or fringes and lipping of the edges of the joint (Fig. 35). If the arthritis attacks the back, it often starts in the last dorsal and first lumbar vertebræ. Small spurs of bone appear from the sides of the bodies of the adjacent vertebræ. Later the spurs bridge over, the lower edges dove-tailing into the upper, so that a firm locking of the joints ensues. The pain and discomfort then usually become less pronounced. The patella fat pad is not infrequently involved in hypertrophic arthritis of the knee-joint. It becomes calcified and shows in the *x*-ray as extra fringes around the rim of the joint. These fringes sometimes break off and form loose bodies which are sometimes called "joint mice." In other cases spurs may break from the patella fat pad and become calcified. Restriction in motion and "locking" of the joint may result when these bodies get between the joint surfaces. The Bier method of venous constriction helps to flush the joint with arterial blood. The knee-joint is the one that most easily adapts itself to the pressure bandage type of treatment, therefore its application for this joint is described below.

Two rubber bandages $2\frac{1}{2}$ inches wide are used. One is wound from the foot to below the knee-joint firmly enough to stop the venous circulation, but not the arterial. The second bandage is snugly wound just above the joint. There should be no pressure whatever over the joint capsule. The upper bandage is left on for

from three to five minutes at a time. It is then removed in order to allow the blood to flush the part. This performance is repeated three times. The lower bandage is kept permanently adjusted during these three flushings. Then it is removed and the blood from the lower restricted area is allowed to flush the joint. The muscles above and below the knee should be kneaded and stroked following the Bier method. Heat in some form may be preferred to produce a hyperemia in place of the method described above. At no time should pressure be exerted on the affected joints. The lightest form of surface stroking will help the circulation in the peripheral vessels without causing irritation in the joint. Gentle assistive or passive movements are often given. Rough handling or movements of a jerky nature should be carefully guarded against at all times. In the knee-joint the hamstring muscles have a tendency to contract. This causes limitation of motion in walking. To rectify this condition the patient may be instructed to push down on the heel from the lying position. At the same time the operator may assist the stretching of the hamstrings by grasping the leg directly beneath the knee-joint with the left hand, and directly above with the right hand, and, simultaneously with the patient's effort, exerting a steady pull on the posterior thigh muscles. Static electricity is claimed by some to give excellent results and should be preceded by heat penetration or ionic

medication. The static de Kraft blue pencil effleuve, the spark, and the Morton wave are good modalities to use. The current is applied to the affected part for the purpose of helping to disperse the organized products of inflammation, to open the venous and the lymphatic channels, and so allow the broken-down residue to be carried off through the circulation.

CHAPTER VII

THE NERVOUS SYSTEM; FUNCTIONAL DISTURBANCES—NEURALGIA, NEUROSIS, NEURASTHENIA; ORGANIC DISTURBANCES—NEURITIS, PARESIS

In a functional disturbance there is a derangement of the normal activity of an organ, but no change in its structure. In an organic disturbance there is a structural change in the affected part the result of disease of an organ or of a part of the body.

Functional and organic nerve disorders and their treatment by means of physical therapeutic methods will be discussed in the three following chapters. In functional disturbances electricity in combination with massage and exercise is much favored. In organic disturbances individual muscle and muscle group training for the restoration of function of the impaired muscles is valuable. Exercises also of re-education play an important part in the treatment of cerebrospinal types of paralysis.

Functional Disturbances

NEURALGIA

Neuralgia is pain in a nerve. It may be of cerebral, spinal, or visceral origin. The seat of pain is not always identical with the seat of the pathologic condition. Re-

ferred pain, or paroxysms of pain, are not at all unusual. Tenderness is often felt in the area supplied by the most superficial branch of the nerve. Dampness, cold, extreme fatigue, or injury from a blow are the most frequent causes of neuralgic conditions. The most common forms of this disturbance are intercostal neuralgia and neuralgia of the trigeminal or fifth cranial nerve (tic douloureux). In the former, gentle effleurage and kneading over the affected area is helpful in severe or recent cases. If friction or vibration is used over painful points, it should be administered with firm, continuous pressure. This will sometimes react in a decidedly sedative manner. In the subacute or in chronic conditions deeper and heavier treatment throughout is indicated.

Sometimes the application of electricity is used. In the acute stage the static brush, over the affected area, is helpful. In the subacute stage a solution of sodium salicylate is driven into the tissues by means of the constant current. In ionization the negative electrode is soaked in a 2 per cent. solution of sodium salicylate and placed over the affected part. The indifferent electrode may consist of the attachment of the positive electrode to a foot-tub of warm water. This treatment should last from twenty to thirty minutes, 3 to 15 milliamperes of current being used. If the pain is on the left side of the chest in the precordial region, great care should be observed in watching the pulse of the patient, and

no sudden change should be made in the strength of the current.

In the most common form of neuralgia, when the fifth cranial nerve or its division is affected, facial massage may be of appreciable benefit. Effleurage and finger-and-thumb pétrissage of all the muscles of the face is given, followed by finger vibrations over the three cutaneous branches of the trigeminal nerve. The index-finger is made to vibrate firmly first over the most cutaneous region of the supra-orbital nerve, the infra-orbital nerve, and the most superficial part of the inferior maxillary division of the fifth cranial nerve that lies between the angle of the lower jaw and the middle line of the face. Effleurage of the face completes the treatment, the strokes being carried with each hand from the middle line of the face to beneath the lobe of the ears.

NEUROSIS

A neurosis is a functional nerve disease. It is an affection of the nervous system in which there is a marked functional disturbance occurring without any apparent cause. Disease is inconceivable without some underlying physical basis. The lesion need not be visible even microscopically; it may be either of molecular or of biochemical origin. Many cases of functional war neurosis completely cleared up with intelligent care. In cases in which functional paralysis is present function may be gradually restored by the encourage-

ment of some occupational or vocational activity, in combination with some form of outdoor sport. Along with the activity, regular systematic treatment, consisting of massage and the Bristow faradic or the sinusoidal currents over the affected muscles, have been used to advantage. This treatment encourages nutrition in the muscles and closely imitates normal muscular action. If contractures are present, stretching of the muscles and splintage between treatments will aid in restoring normal function.

NEURASTHENIA

Neurasthenia is a result of the exhaustion of the nervous system. There may be a disturbance in the motor mechanism, resulting in inability to perform definite muscular actions; in the sensory equipment, resulting in hypersensitivity to heat and cold; or in the autonomic system, resulting in gastro-intestinal trouble. The close relationship existing between the cerebrospinal and autonomic systems is such that disturbance in one must naturally affect the other. Physical therapeutic measures are often more effective than any other kind of treatment. The modified Wier Mitchell treatment, as described in Chapter IV, is frequently prescribed for neurasthenic patients. Daily treatments of massage are given in combination with electricity. By using the sinusoidal current or the faradic current of the Bristow coil contraction of the various muscle groups in the upper and lower extremity may be obtained.

Organic Disturbances

NEURITIS

Neuritis is an inflammation of the nerve and of its peripheral endings. Infectious diseases and toxins sometimes produce this condition. We may speak of three distinct stages of neuritis—the acute, the convalescing, and the regenerative. No massage is indicated in the acute stage. Rest and warmth are essential. The application of the cobalt-blue light over the affected area for ten to fifteen minutes has been found to have a sedative value both because of the heat and the color of the light, or an application of diathermy. Only with the greatest amount of care and gentleness should massage be given in the convalescing stage. In the regenerative stage massage and passive exercises are indicated. In a brachial neuritis an application of electricity in the form of the constant current is made, preferably before massage.

For the negative electrode a large well-soaked pad extending from the wrist to the elbow-joint is placed over the brachial plexus and the positive electrode is placed on the arm. From 2 to 12 milliamperes of constant current are given from twenty to thirty minutes.

PARESIS, WRITER'S CRAMP

Paresis is a partial paralysis, often resulting from some such form of muscle fatigue as writer's cramp. It is usually found in persons who have overused the hand in writing. Writer's cramp comes into the class

of occupational neuritis. In each case the paresis occurs in the muscles which are overworked. It is most often found in persons having a general lowered resistance. Complete rest from the occupation which employs the fatigued muscle groups should be insisted upon from the beginning of the symptoms of the trouble. In writer's cramp, kneading and effleurage of the affected arm are beneficial, and special attention should be paid to the posterior muscles of the forearm. Gentle passive movements to the wrist- and elbow-joints are given from the start. A little later, passive and assistive movements, followed by positive resistance movements (Chapter II, Part I) are applied to the extensors and abductors of the thumb. Short treatments twice daily are to be preferred.

In the acute stage rest and the application of diathermy has been found of great advantage. For three or four treatments at the first the penetrating heat has a sedative effect as well as flushing the part with fresh blood. From 300 to 600 milliamperes of D'Arsonval type of high-frequency current is used for thirty or thirty-five minutes daily. After several treatments of this kind massage of the limb may be added, preceded by twenty minutes of diathermy. In the recuperative stage the positive pole of the constant current may be used to great advantage. The indifferent electrode is placed at the back of the neck, and the positive or active electrode is placed on the affected muscles.

CHAPTER VIII

THE NERVOUS SYSTEM (Continued)

ORGANIC DISTURBANCES—PARALYSIS: CEREBROSPINAL, SPASTIC (HEMIPLEGIA); LITTLE'S DISEASE; TABES DORSALIS; FLACCID PARALYSIS (INFANTILE PARALYSIS)

PARALYSIS, CEREBROSPINAL

Paralysis is the result of some lesion either in the brain, the spinal cord, the nerve trunks, or in the terminal branches of the nerves. The lesion interferes in some way with the transmission of the nerve impulses. Paralysis of cerebral origin is almost always of the hemiplegic type, and is so called because one side of the body only is affected. Paralysis of spinal origin frequently affects both halves of the cord, resulting in a paraplegic condition. In general, paralysis may be divided into the spastic and flaccid types. Hemiplegia is an excellent example of the spastic type, being an affection of the upper neurons. Infantile paralysis is an excellent example of the flaccid type, being an affection of the lower neurons.

SPASTIC PARALYSIS (HEMIPLEGIA)

Spastic paralysis is known as the upper neuron type of paralysis because the lesion is in the upper neurons

either in the brain or in the spinal cord. Hemiplegia is a common type of spastic paralysis; it may be the result of a cerebral hemorrhage or cerebral embolism. An injury to the skull may be followed by spasticity of the muscle groups of the extremities on either side of the body. An affection of the upper neurons between the brain and the spinal cord at any level of the cord will result in a total or partial paralysis of the muscles supplied by the nerves distal to the injury according to the severity of the lesion.

The characteristics of spastic paralysis are an increase of reflexes and hypertonicity of certain affected muscle groups. The affected muscles show no reaction of degeneration. This form of paralysis is of the non-atrophic type. The upper neurons do not control nutrition. The brain is the center of inhibition, and it is the lack of inhibition that causes the spasticity of the muscles. Injury to the gray matter in the cortical area destroys the originative and receptive centers. Injury to the white matter destroys the path to and from the centers. Voluntary impulses arise in the pyramidal cells in the gray matter of the cerebral cortex in the precentral area near the fissure of Rolando. Injury to the precentral area in the left hemisphere results in a hemiplegia of the right side, and vice versa, owing to the decussation of the motor nerves in the crossed pyramidal tract.

In the hemiplegic type of spastic paralysis treat-

ment is calculated to re-establish muscle balance. The object of the treatment is to encourage voluntary action in the relaxed groups, in which case the spasticity will inevitably be overcome to some extent in the antagonizing muscle groups. In both the upper and lower extremities the muscles chiefly spastic are the flexors, pronators, inward rotators, and adductors. The gait of the hemiplegic is marked by a jerky outward throw of the affected leg and thigh, this resulting from the spasticity of the deep flexors of the thigh. The hamstrings and the gastrocnemii muscles are also usually spastic, causing the heel to be raised, the knee slightly flexed, and a dragging of the toes while walking. In the upper extremity the arm is carried closely against the body, rotated inward from the shoulder, and the hand is in the prone palmar flexed position, the thumb being tightly flexed across the palm. In the early stage of hemiplegia, if the cause of the trouble is the bursting of a small blood-vessel or embolism, rest and quiet are indicated until the physician in charge feels that the danger of a recurrence is past.

In the early stage of treatment gentle deep kneading of the relaxed muscles (to increase their tonicity) and light stroking only of the spastic groups (to help to overcome their hypertonicity) is called for until the convalescent period is reached. It may be two or three weeks before voluntary movements involving upper neuron training of the relaxed groups can be encouraged.

Any forcible stretching of the spastic muscles is contraindicated because greater spasticity is liable to follow such treatment. The operator may be able by rendering gentle assistance, accompanying voluntary movements, to further extend or abduct the limb, at the same time giving slight traction to the joint, but no force should be exerted, as such is liable to increase contractility in the already spastic groups. Later prescribed voluntary exercises have proved to be of value, especially those of a competitive nature in game form wherein a certain amount of excitation as a stimulus is present. In Part II, Chapter VIII an outline of prescribed exercises incorporating Dr. Sheperd Ivory Franz's theory of competitive games is given in detail. These exercises have been tried on various groups and have been found helpful. Any form of voluntary exercises which bring strongly into play the relaxed muscle groups of the upper and lower extremities may be used to advantage. The ingenuity of the operator is called into play to furnish these exercises.

LITTLE'S DISEASE

Little's disease is a form of spastic paralysis that occurs in child life. The condition may be congenital, the result of some injury at birth, or it may follow some acute infectious disease in childhood. The trouble may take the form of one-sided paralysis, or there may be spastic diplegia of the upper and lower extremities.

The disturbance of muscle balance in children resulting in contractures is liable to be followed by deformities, and operative measures to tendons and muscles may be considered advisable. Physiotherapy treatment, especially in the form of voluntary exercises, should be given first consideration in preference to early operative measures. If later an operation is considered necessary, then physiotherapy treatment plays a big part in the after-care. A marked feature in infantile spastic paralysis is lack of co-ordination; exercises that bring muscle balance into play should receive careful consideration. Massage is indicated similar to that described for hemiplegia in which the hypotonic extensors, abductors, outward rotators, and pronators are kneaded, while the hypertonic flexors, adductors, inward rotators, and supinators are merely stroked to help to relieve the hypertonicity. This should be followed by passive and assistive gentle stretching of the spastic groups, preceded by voluntary exercises for balance and co-ordination, or exercises for the relaxed groups to the accompaniment of some familiar nursery song. Symmetric exercises for the extensors of the upper extremities may be taught before a mirror. Stepping on marked squares and circles alternately, and walking on a straight line, then closing the eyes and doing the same thing will help to re-establish co-ordination in the lower extremities. At the Children's Hospital in Boston Miss Mary

Trainor has worked out some very helpful exercises for the child suffering from the brain and cord lesion types of paralysis. For example, to bring the extensors of the fingers into action, Miss Trainor sings a little descriptive song to the child, and at the same time the child is taught by imitation to go through the actions to the accompaniment of the song, and bringing into play the outward rotators of the arm which are the relaxed groups. The child is shown how to measure off a yard of ribbon and to use it to tie up her hair. The action accompanies a little rhyme in tune, with the result that the child takes a delight in trying to do it instead of finding it drudgery. This kindergarten therapy calls for a great deal of patience, originality, and personality on the part of the instructor. The child is naturally imitative and a great deal can be accomplished by this method. Apparatus for maintaining as much correction as possible is sometimes worn for an hour at a time, or often several times a day. For contractures of the fingers a simple padded metal splint is used. This is strapped on with the wrist held in slight palmar flexion so that extension of the fingers is easier. As a mark of progression the wrist is brought into the straight position, the fingers still extended, and later slight dorsiflexion of the wrist may be taken, the fingers being kept in extension. Corrective apparatus to accomplish similar results may be used for the elbow, shoulder, and lower extremi-

ties. Each child presents a definite problem and therefore should receive individual attention.

TABES DORSALIS

Tabes dorsalis is due to a degeneration of the posterior roots, the posterior tracks, and, it may be, of the spinal ganglia of the cord. There is injury of the sensory branch of the reflex arc, causing a wasting of the dorsal fibers of the spinal cord. The kinesthetic sense (the sense of movements) is lost. The patient lacks co-ordination, although he retains sensations of heat, cold, etc. There is no paralysis of the muscles as in the lower neuron lesion type, nor is there marked spasticity as in the upper neuron lesion type, the most prominent symptom being the inco-ordination of the muscular movements. Locomotion is a profound and complex function. The Frenkel method of treatment claims to bear favorable influence upon the most prominent symptoms, and aims at the re-establishment of co-ordination.

The success of the treatment by exercise depends upon the coexistence of a period of stability in the course of the disease, and no obvious increase in symptoms. Medical treatment should precede and supplement from time to time treatment by exercise.

In tabes there is a lack of co-ordination in body balance when the patient walks. One heel is frequently placed on the ground with marked precision. The legs are

held far apart in walking because of a subconscious effort to maintain balance. The eyes of the patient usually carefully follow the movements of the limbs, otherwise the movements are much less co-ordinate. If hyperextension in the knee-joint is present, the trunk is bent forward. This compensatory action takes place in order to maintain equilibrium. Lack of flexion in the knee often results in outward rotation of the thigh. The leg *en masse* is carried forward in an outward roll, and there is no spring in the gait. All the muscles show some signs of hypotonia, although there is often little change in their contour. In the advanced stage there is a general marked hypotonicity of the muscles. The joints become flail-like, with little or no stability. Dr. H. S. Frenkel has developed his so-called "compensatory exercise therapy," his theory being that the blind have a greater tactile sense than those that see. Voluntary exercises for the tabetic are prescribed and based on the theory of the education of the central neurons by means of repeated exercise. As the exercises become more familiar, the fatigue is less, and the movements are more co-ordinate, shutting out unnecessary movements. The attention of the patient is necessary, and at first all the movements of the limbs are performed with the patient in the lying position, the head being raised sufficiently so that the eyes can carefully watch all the movements. After repeated efforts, when control is gained, the patient

is asked to go through the exercises again, this time closing the eyes. Little or no apparatus is necessary. Frenkel uses a staircase for his patients and teaches, them to climb and come down, first with the eyes watching the movements and later with the eyes closed. A list of detailed exercises incorporating Dr. Frenkel's system is given in Chapter X, Part II.

FLACCID PARALYSIS (INFANTILE PARALYSIS)

Flaccid paralysis is known as the lower neuron type, in which there is a lesion of the lower neuron. Its characteristics are a decrease or loss of reflexes, with flaccid muscles, or a hypotonicity of the muscle groups controlled by the affected neurons. The affected muscles show "reaction of degeneration."

Anterior poliomyelitis or infantile paralysis, as it is commonly called, is an excellent example of the flaccid type which chiefly affects the anterior horns of the spinal cord. It is an acute infectious disease. The probable port of entry of the infection is through the upper respiratory tract, through which the bacilli pass into the blood-stream and attack the spinal cord. The first pathologic stage of the disease is an acute interstitial meningitis, which is usually more marked in the anterior horn of the spinal cord, in which the blood-supply is more abundant. The blood-vessels enter the cord in the anterior cleft near the anterior horn. The cervical and lumbar enlargements of the cord are most often

affected. The damaging effects are to be attributed in part to direct pressure on the nerves of hematoma, edema, and exudate; to anemia, following constriction of the blood-vessels; and to direct toxic action of the virus itself on the nerve-cells. The nerve-cells degenerate on account of the pressure and anemia. If nature absorbs the hematoma and exudate soon enough, thus relieving the pressure, the cells may recover function; if, however, the unfavorable conditions are too prolonged or too excessive, the nerve-cells may undergo complete degeneration. Epidemics of infantile paralysis are most common during the summer months in child life.

In order to impress the reader with the fact that treatment of any kind is not warranted until all danger of recurring inflammation in the spinal cord has passed, we shall speak of the acute and convalescing stage. The acute stage is best distinguished from the convalescing by the disappearance of pain and sensitiveness. Physiotherapy should be commenced as early as possible in the convalescing stage, in order that nature may be assisted during her regenerating nerve processes, and that the muscles may be kept as healthy as possible during the nerve recuperating period.

If pain or sensitiveness reappear after massage and muscle training are commenced, they should be stopped immediately, as persistent treatment may retard progress at this stage by increasing inflammation, thereby causing further damage in the spinal cord.

Heat applied to the spine during the acute stage is helpful, but the patient should be kept absolutely quiet. If there is a general muscle weakness of the leg a "cradle" placed over it will keep the bed-clothes from extending the ankle, and prevent the possibility of foot-drop later. Every opportunity should be taken to use simple extension apparatus, or any device for the prevention of possible deformities. The one in charge should be most strongly urged not to permit the patient to assume malpositions, as these may later result in deformities. If the lower extremities are affected, the patient should not be allowed to attempt walking until the muscles are strong enough to bear the body weight, or until any weakened group is well supported by some apparatus, such as a long or short caliper splint if the quadriceps are weak, and a special shoe that takes any strain of weight bearing from a weakened anterior tibial group or peroneal group. Operative methods are not usually employed until after nature has been given every chance to work her own recuperation. Massage and muscle training are nature's aids, and of great advantage to the patient in the recuperative period.

Following a tenotomy operation it is very essential that massage and muscle re-education be started in the transplanted muscle not later than three weeks after operation, as prolonged disuse will cause inability to regain normal muscle function. Weight bearing should be avoided after a stabilization of the tarsus or astraga-

lectomy operation for at least three months or more; then, in order to maintain correct position of the structure, a support is sometimes worn after the removal of the cast. This recuperative period may last several years, according to the severity of the case. Constant re-education of relaxed muscle groups may prevent structural deformity from occurring. In the case of children it is hard to prevent deformities, because the growing bones adapt themselves to the position held. If almost full growth is attained before the attack, the problem of possible bony deformities is not so great, but stretching of weakened muscles should be carefully guarded against at all times in every type of case.

Treatment in all cases of flaccid paralysis should consist of massage and muscle training. The former improves the nutrition of the muscle-fibers, and the latter stimulates the nerve impulses which are impaired, Certain nerve-cells supplying a muscle or group of muscles may appear to have been destroyed, and it may be difficult to determine how wide a course this destruction has run, but at times it is surprising and intensely gratifying to see large muscle groups, heretofore inactive, show signs of voluntary action after long months of massage and muscle training. The muscle training not only stimulates the nerve impulses, but also brings about better co-ordination of the partially functioning nerve-fibers. According to Josiah Royce, in his book "Outlines of Psychology," published in

1904, "parts that have often functioned together tend to function more easily together again." It requires very careful and patient study on the part of the operator, as well as the patient, to persist in this work. It is well to train the mother or the person in charge of the child to give daily attention to this training, as it may have to be carried on for many months or even for years. A child cannot be expected to exercise alone. He requires some outside stimulus, and many words of encouragement. A correct mental attitude in the patient should be encouraged, and it is better to have no one but the person in charge present during the exercises, as it is imperative that all the patient's attention should be concentrated on his own voluntary efforts, if good results are to be accomplished.

Routine exercise without the patient's mental co-operation, or purely passive exercise, is of little value and does not enter into the class of muscle re-education. It is well to administer the exercises on a smooth, unyielding surface. A soft bed or couch that sags is useless. It is interesting to watch different muscles compensate for non-functioning ones, and the operator must always be on guard to distinguish this compensatory muscular action, or he may easily be deceived. This compensatory action may be of great advantage later, but the muscle training should aim to encourage activity in non-functioning muscles or in muscles that are functioning feebly. The part having exercise should

be uncovered during the exercise period, so that the instructor may be on the alert for any new signs of activity in the muscles.

The patient should make every effort to perform the exercises. While one hand of the operator is placed in the center of the muscles that are being exercised, the other hand offers assistance or resistance, according to the power of the muscle. Each arc of motion should be carried to its limit. If the patient cannot do this alone, the instructor should assist, and the exercises should be performed from six to ten times each, allowing a slight pause between each movement to avoid muscle fatigue. Although it is impossible to set down any given rule, it is well to have some general understanding as to classifications.

The age and the possibility of intelligent co-operation on the part of the patient must decide whether or not muscle training is worth while. It is a waste of time to attempt to train a child who is not old enough to concentrate, or a child who lacks the intelligence to do so. It is hard to say that at any particular age a child is able to understand concentrated effort, for this ability varies greatly with the individual. An approximate figure only can be mentioned, and this might be from six to eight years of age. A thorough test of the musculature in general should be made at the outset of treatment. At this time poorly or non-functioning muscles should be recorded in order that progress or

otherwise be noted. In the convalescing period, if the patient is able to walk, a study of the peculiarities of gait gives the instructor a cue as to which muscles are chiefly affected in the lower limbs. The matter of knowledge by means of gait is one that can only be understood after careful individual study of many cases. The operator must bear in mind the possibility of compensatory muscle action. In no disease is this so evident as in infantile paralysis.

The method of testing muscles is the same as that used for the training of poorly functioning ones. The method given below claims by no means to be exact. Apparatus for testing muscles has proved to be of little real value. There is a spring balance test used at the present time. Its object is to test the muscles in their various groups, under conditions of constant position and leverage, and then to test similarly at intervals of three months or so. The accuracy of this test so largely depends upon the exact technic of those applying it that its usefulness is doubtful unless the same operators can be employed each time the case is tested. Because of these limitations it is evident that the use of testing apparatus is impractical and at times may even be misleading.

Treatment.—The child should be stripped in order that the complete outline and action of the muscles may be noted, or at least the limbs one at a time should be free from clothing during examination and treat-

ment. The child is asked to stand still, and unnatural positions of posture are noted; next he is asked to walk in order that limps and pecularities of gait, and the existence of fixed deformities, if present, may be observed. If he is unable to stand or walk the examination would necessarily start from the sitting and lying positions which are next in order. To test the muscles of the trunk, the patient lies with the back supported on a flat unyielding surface, the arms are folded across the chest, and the thighs are held down securely. He is asked to rise to a sitting position in order to test the deep flexors of thighs and the hips, and the abdominal muscles. If the thigh and hip flexors are paralyzed and the abdominals are working, the patient will be unable to rise to a sitting position, but the abdominal muscles will be felt to contract strongly. If the abdominal muscles are weak, but the thigh and hip flexors are working, the patient may be able to rise, but will do so with a great effort and the back will be hollowed. The abdominal muscles also will protrude and visibly show a lack of tone. If one side only of the abdominals are weak the umbilicus during the exercise will be drawn away from the weakened side. To test for the extensors of the spine the patient lies face down and the legs are firmly held. He then tries to raise the head and shoulders from the table. If the muscles on one side only of the spinal column are weak this will be shown by the unsymmetric action of the erector

spinæ muscles while raising the head and shoulders. Lateral flexion may be tested by having the patient sit erect, the legs hanging over, the arms folded, and the hips firmly held; he is then asked first to bend to the right and then to the left. Normal lateral flexion should be the same on each side.

The muscles of the upper extremity are next tested in their respective groups as follows: the muscles that raise the shoulder-girdle; the muscles that raise the arm above the shoulder; the muscles that move the arm across the chest; the muscles that move the arm backward; the muscles that rotate the arm outward; those that rotate it inward; the muscles that flex and extend the forearm; the muscles that pronate and supinate the forearm; and the muscles that flex and extend the wrist and the fingers.

Each group is tested separately and, where it is possible, the action is tested against the pull of gravity. Graded resistance is added by the operator. Normal muscles should be capable of performing their action against a fair amount of graded resistance and against gravity. If the muscles are capable of action against gravity, but become limited in action when resistance is applied, they may be classified as three-quarters normal. If the muscles are capable of only limited action against gravity alone, they may be classified as half normal. If the muscles are capable of no action against gravity, but of limited action if gravity is elim-

inated (as in the side-lying position), they may be classified as one-quarter normal. If the muscles quiver, but are not strong enough to show movement, they

Fig. 36.—Showing atrophy of posterior scapula muscles, the muscles of the right leg with equino deformity and relaxation of the abdominals.

may be classified as a quiver. If the muscles show no signs of movement of any kind, they may be classified as paralyzed totally.

The lower limbs are tested in the same grouping system and similarly classified as those of the upper extremities. The manner of rendering assistance for muscles belonging to the half normal class will be given as follows: The operator grasps the limb and passively makes three rhythmic movements. The patient is then asked to do the same by voluntary motion in groups of three, resting a second between each group. As the muscles become stronger, carefully graded resistance may be added as described in Part I, Chapter II. If the response of the muscles is below half normal the exercises had better be performed in the side-lying position. In this position the weight of the limb is supported, and all the muscles will have to overcome will be the friction of the plinth. In this class the exercises are assistive. The patient lies with the part to be exercised in the most advantageous side-lying position for the performance of voluntary motion. The operator grasps the limb with one hand, while the other is placed near the middle of the muscles that are to be exercised. The patient is then asked to make all the voluntary effort possible to contract the muscles; then the operator carries the movement to its full arc of motion. This movement is repeated for six or ten times, with a short rest between every second or third movement. The number of times each exercise is done depends entirely upon evidence of fatigue in the muscle. Exercise should never be continued in a weak muscle after the first

sign of fatigue. The muscle reaction after each movement should be carefully watched, and if the reaction varies after the first movement and the movement shows signs of being sluggish, exercise should be stopped. The operator should train both eye and fingers to be conscious of the slightest change. Assistive exercises should be discontinued and replaced by voluntary exercises, to which should be added carefully graded resistance as soon as signs of improvement are noted. If the muscle is capable of acting against the pull of gravity this is a good time for introducing resistance which should be very carefully administered following the law of muscle action (see Chapter II, Part I). The same procedure for muscle training is indicated as that described above for muscle testing. Heat preceding massage and muscle training may be used to advantage. Local baking, using either an electric-light bulb or an electric baking machine, may be used to induce a hyperemia. A convenient way to handle children is to have them lie in a warm bath for ten or fifteen minutes preceding massage and exercise. After such a bath care must be exercised to keep the child in a well-heated room, free from drafts, as much of the body surface is liable to be exposed during treatment. Each affected muscle group should be thoroughly kneaded and stroked preceding exercise, and the patient should rest for fifteen or twenty minutes immediately after the treatment.

The following method of classification may be helpful. It has been tried out with simplification in view and a working basis of understanding between the doctor in charge and the one who is supervising the exercises. Exact measurement of muscle action is impossible, but some common ground of understanding seems necessary.

N. = The muscle is capable of normal action against gravity and against outside resistance.

$\frac{3}{4}$ N. = The muscle is capable of action against gravity, but limited action when outside resistance is given.

$\frac{1}{2}$ N. = The muscle is capable of limited action against gravity, but cannot function when outside resistance is given.

$\frac{1}{4}$ N. = The muscle is capable of no action against gravity, but of limited action if gravity is eliminated, *i. e.*, in the side-lying position it is capable of overcoming the friction of the table.

Q. = The muscle shows a quiver, but is capable of no movement.

T. P. = The muscle shows no signs of movement. It is totally paralyzed.

The N. minus and Q. plus may be used to indicate finer degrees of distinction.

Key to Signify Classification

T. P. = totally paralyzed; Q. = quiver; Q− = not quite sufficient movement to see quiver. $\frac{1}{4}$ N. = one-quarter normal; $\frac{1}{2}$ N. = one-half normal; $\frac{3}{4}$ N. = three-quarters normal. −N. = just under normal; N. = normal action.

A chart of the muscles of the trunk, the upper and lower extremities for each patient, may be kept and recorded at the time the muscles are first tested, then checked and recorded at regular intervals of two or three months.

CHAPTER IX

THE NERVOUS SYSTEM (Continued)

PARALYSIS: PERIPHERAL, MUSCULOSPIRAL, ULNAR, MEDIAN, SCIATIC (EXTERNAL AND INTERNAL POPLITEAL), OBSTETRIC, FACIAL; PROGRESSIVE MUSCULAR ATROPHY; PROGRESSIVE MUSCULAR DYSTROPHY

PERIPHERAL PARALYSIS

This may be caused by disease, but more frequently is the result of injury in the course of the motor nerves. As well as a lack of voluntary movement in the affected muscles, there is usually an accompanying change in sensation. This sensory disturbance corresponds to the distribution of the affected nerve to the skin. Peripheral lesions of the cranial nerves and of the nerves of the brachial plexus and the sacral plexus, and their treatment by massage, and especially muscle training, is discussed.

Peripheral lesions may result in sensory and motor disturbances, with loss of reflexes. Following injury of the back a whole cross-section of the spinal cord may be affected, or one tract only. There may be a lesion of the posterior horn with its accompanying sensory disturbance, causing ataxia.

Peripheral nerve disturbances are of four types: (1) Those in which there is complete anatomic interruption; (2) those in which there is physiologic interruption; (3)

those in which there is compression, the nerve being bound in scar tissue; (4) the irritative type, those in which the nerve is injured, but not divided. The accompanying symptoms vary in each of the above types of paralysis. The sensory disturbance also differs; the anesthetic area in a complete interruption does not improve, while in a partial or compression paralysis this area may improve and even disappear entirely. In the irritative type there is a marked hyperesthesia and hyperalgesia. Trophic disturbances are found in all types of paralysis, but are not necessarily present. Trophic disturbances are more pronounced in the irritative type, and often accompany the partial and compression paralysis. Trophic ulcers and pressure sores are more frequently present in the sciatic lesions. The heel and the external malleolus show this to a marked degree.

The action of the sudoriferous glands throughout the distribution of the affected part is either increased or decreased. In many nerve-lesion cases massage and muscle training may be started as early as possible in the hope that these agencies will render assistance during the regenerative period. When signs of regeneration do not appear after many months of watchfulness, operative methods may be resorted to in both the irritative and compression types. The nerve is freed from binding fascia and tendons or from hard bony surfaces. Within a very short time after the operation massage for the muscles and movements to the joints is prescribed.

In a partial or complete interruption of the nerve neuromas are often removed and at times nerve-suture operations performed. After operation, while nerve regeneration is taking place, the limb is placed in a cast made in two parts, so that the anterior part may be removed for the administration of treatment. A brace is often substituted in place of the cast in about ten days' time, and massage and muscle training are started. Following a sciatic or external popliteal nerve suture the limb is gently and regularly stretched by gradually decreasing the degree of flexion of the limb by the application of a new cast.

In industrial accident cases at times all three cords of the brachial plexus are injured, then complete paralysis of the brachial plexus is liable to be found. In many cases of peripheral nerve lesion the idiomuscular reflex is increased; especially is this so in the early period of regeneration.

MUSCULOSPIRAL PARALYSIS

Musculospiral, ulnar, and median types of paralysis result from injury of the different cords of the brachial plexus. The musculospiral is a common type of paralysis found among industrial accident cases following injury of the arm. An injury in the outer portion of the upper third of the arm will result in a musculospiral paralysis. Because of the extensive distribution of this nerve and of the numerous muscles which it supplies there is danger of deformity of the hand, the typical symptom of which is

"drop-wrist," unless great care is taken during the regeneration of the nerve. A splint should be worn to support the muscles during the regenerative period. If the nerve lesion is slight and if the muscles supplied by this nerve are kept in good condition, massage and passive and assistive exercises of the joints will materially assist the muscles in gradually regaining their normal function. Once nerve regeneration is well under

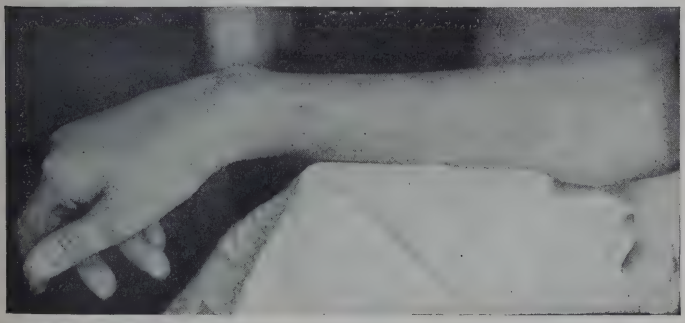


Fig. 37.—Wrist-drop deformity in musculospiral paralysis. After each treatment the wrist extension splint is worn.

way, final recovery may be expected, provided the atrophy of the muscles is not allowed to progress.

If the lesion is above the insertion of the triceps, the extensors of the arm are the first to regain their function. The extensors of the wrist on the radial side, because of a greater muscular distribution, show signs of recovering their power of action earlier than those on the ulnar side. If assistance is given by the operator in extension of the first phalanges, where they articulate with the

metacarpal bones, then the patient is able by his own volition to extend the second and third phalanges. This action is not controlled by the extensor communis digitorum, which is supplied by the musculospiral nerve, but rather by the posterior interossei and the terminal slips of the lumbricales, which together form an aponeurotic tendon and extend the second and third phalanges, the extensor communis digitorum playing only a minor part in the extension of the last two phalanges.

The treatment for a musculospiral paralysis should consist of a daily massage of the entire limb, preceding special kneading of the muscles on the posterior surface of the hand, forearm, and arm. Assistive exercises for the extensor muscles should be given. As soon as any trace of return of function is noted less assistance should be given, and at the earliest opportunity carefully graded resistance should be added. A soft roll placed in the palm acts as a support to keep the wrist in extension during manipulation. From six to eight muscle contractions are given and from 7 to 10 milliamperes of interrupted galvanic current are used over the motor points of the affected muscles. The negative pole is the active electrode and is placed on the motor point of the affected muscles. This, following massage, will aid in muscle contractions if voluntary nerve impulse is lacking. In all cases in which there is a complete (R. D.) reaction of degeneration the positive electrode is the active

one until some response to the negative pole is felt. As soon as nerve response is manifest the slow sinusoidal current or the Bristow coil is substituted for the interrupted galvanism, two or three minutes being spent upon each muscle group. Exercises are given in extension of the metacarpophalangeal and wrist-joints. Supination of the elbow-joint follows. For all passive and assistive exercises the forearm should be placed in the side-lying position. In this way the pull of gravity is eliminated. In order to prevent wrist-drop deformity the patient should wear a cock-up splint (see Fig. 42) between treatments.

ULNAR PARALYSIS

In an ulnar paralysis the most obvious indications are atrophy of the interossei muscles, anterior and posterior, the posterior showing more marked waste on account of the absence of well-developed fascia. If the lesion is above the internal epicondyle of the humerus, or if it is a complication of a brachial plexus injury, and the flexor profundus digitorum and the flexor carpi ulnaris are not functioning, then the ulnar "griffe" is pronounced. The hand has a claw-like appearance, and there is a hyperextension of the first phalanges and an exaggerated flexion of the second and third phalangeal joints, especially of the ring and little fingers. This is a typical deformity of an ulnar paralysis. The "griffe hand" is less pronounced in a high ulnar lesion,

although the wasting of the interossei and the three muscles on the hypothenar eminence are much the same as in a low lesion. There is liable to be more flexion deformity of the ring and little fingers in a low lesion because of the muscular pull on the ulnar side of the hand.

The treatment for ulnar paralysis consists of massage for the arm, forearm, and hand. There should be spe-

Fig. 38.—Ulnar paralysis, showing atrophy of interossei and muscles of the hypothenar eminence.

cial kneading of the muscles on the ulnar side of the forearm and particular attention should be paid to the interossei muscles. Passive and assistive movements are given to all the phalangeal and the metacarpophalangeal joints. Every effort should be directed toward overcoming the "griffe" deformity. The interrupted galvanic current is applied preceding manipulation and

is replaced by the sinusoidal current or the Bristow coil when evidence of nerve reaction begins to show.

MEDIAN PARALYSIS

The muscles affected in a median paralysis are the pronator quadratus, the pronator teres, the flexor carpi radialis, half the flexor profundus, the flexor sublimis digitorum, and all the muscles of the thenar eminence

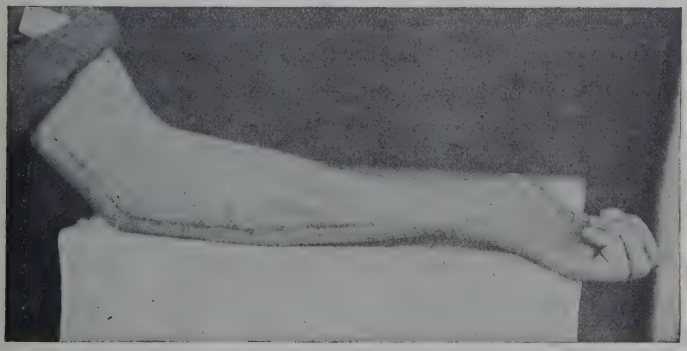


Fig. 39.—Median and ulnar lesion, showing atrophy of thenar and hypothenar eminence, also scar following operation of nerve suture.

except adductors and the deep head of flexor brevis, and the first two lumbricales. The other intrinsic muscles of the hand are supplied by the ulnar nerve.

If there is a complete paralysis above the epitrochlear muscles the position of the hand at rest is not characterized by any special deformity such as is found in the "ulnar griffe" of an ulnar paralysis, or in the "drop-wrist" of a musculospiral paralysis. The loss of certain movements in the hand is the chief means of diagnosis.

Pronation of the forearm is impossible except for a slight action of the biceps muscle. Flexion of the hand upon the wrist is weak because the flexor ulnaris is the only muscle performing the movement. Flexion of the thumb, of the index-, and sometimes of the middle finger is impossible except at the metacarpophalangeal joint. This movement is performed by the action of the interossei muscles. Paralysis below the epitrochlear muscles shows very close similarity to the paralysis above the epitrochlear muscles. With the exception of the flexor profundus and the pronator teres, the same muscles are paralyzed.

The sensory areas of a median paralysis usually have marked anesthesia on the radial side of the palm; on the palmar surface of the thumb, index-, and middle fingers; on the dorsal surfaces of the second and third phalanges of the index- and middle fingers; and very often on the external surface of the ring finger. The extent of these areas varies in each case, but the index-finger always shows the greatest degree of disturbance.

A common test in median paralysis is to have the patient oppose his thumb to the cushion of the little finger. This he can rarely do, but by means of the adductors and deep flexors of the thumb, which are not supplied by the median nerve, the patient may slide the thumb across the palm and touch the flexed little finger on the inside. This is a case of pseudo-opposition, and should not mislead the operator.

The treatment for median paralysis should consist of massage of the entire arm with special kneading of all the flexor muscles. Passive and assistive exercises should aim toward obtaining flexion of the thumb, index-, and second fingers. The patient should be encouraged to try to actively approximate the thumb and little finger. Two useful tests for determining restoration of function in a median paralysis are: first, to have the patient attempt to pick up a pin, and second, to hold the thumb and index-finger in firm approximation against outside resistance. These tests are useful as an exercise. As in the former types of peripheral paralysis, the application of interrupted galvanism to the affected muscles should precede the application of the sinusoidal current or the Bristow coil, until there is some reaction of the affected muscles to the negative pole of the constant current.

SCIATIC PARALYSIS

In a high sciatic nerve lesion, in which there is a complete interruption of the nerve, all the muscles of the thigh that receive any supply from the sciatic nerve, as well as all the muscles supplied by its branches, are affected. In some instances complete paralysis is present in the entire distribution of both main branches. If the interruption is not complete, there may be paralysis of either the external popliteal or of the internal popliteal nerve, with a mere weakening of the other.

A high lesion will necessitate a longer regenerative period than a low lesion, because, in the case of the former, the axis-cylinder has a longer distance to grow. Regeneration takes place from the point of sequence nearest the center, and progresses toward the terminal branches of the nerve-fibers. In a sciatic paralysis the internal popliteal nerve usually regenerates first, which means that the deep muscles supplied by the posterior tibial branch of the internal popliteal nerve—for example, the soleus and the gastrocnemius muscles—are the first muscles to show signs of a return of function. The muscles supplied by the anterior tibial branch of the external popliteal nerve are usually the next to regain function, the peronei group first, and next the dorsiflexors of the ankle. Among the last to return is the tibialis posticus, which is supplied by the posterior tibial nerve. A test for determining whether there is a paralysis of the internal popliteal nerve is to ask the patient to rise on the toes. This cannot be done if the posterior tibial nerve is not intact, because the gastrocnemius muscle will not be able to do its part in the exercise.

Massage and muscle training are the best means of treatment both in the preoperative and the postoperative cases. In all instances assistive movements to the joints should be given in the side-lying position whenever it is practical, in order to eliminate the pull of gravity. If there is no trace of nerve impulse, interrupted

galvanism, in which the negative electrode is used over the motor point in the muscle supplied by the affected nerve, and the positive electrode is placed upon another part of the muscle or else over the spinal plexus. As soon as nerve response is found in the muscle, then the slow sinusoidal current or the faradic current of the Bristow coil is substituted for interrupted galvanism.

External Popliteal Paralysis.—This is a common form of paralysis of the lower extremity. An injury in the vicinity of the knee-joint and over the head of the fibula is very often the cause of injury to the external popliteal nerve or its branch, the anterior tibial nerve. The muscles supplied by this nerve become powerless. The so-called "drop-foot" is a typical deformity of the external popliteal paralysis. A foot appliance is worn not only during the regeneration period, but usually until the anterior tibial muscles are strong enough to maintain the foot in full dorsiflexion. The foot should be supported in dorsiflexion during treatment. A soft roll placed against the sole of the foot will act as a support.

Treatment should consist of massage of the foot, leg, and thigh, with special finger-and-thumb kneading of the anterior tibial and peronei muscle groups. Inversion, eversion, and dorsiflexion exercises should be passive until sufficient muscle response appears to make assistive movements the principal form of exercise. The daily application of from 5 to 10 milliamperes of interrupted galvanic current is useful in combination with the

above treatment. From six to eight muscle contractions are given to the tibialis anticus, the extensor longus digitorum, and to the peronei muscles. When nerve response is evident the galvanic current is substituted by the slow sinusoidal current or by the faradic current of the Bristow coil.

Internal Popliteal Paralysis.—This form of paralysis is not so frequently found as the former. The principal muscles involved are the ones that comprise the gastrocnemius group and the plantar muscles of the foot. These muscles are supplied by the posterior tibial branch of the internal popliteal nerve. Massage, assistive exercises, and the application of interrupted galvanism, subsittuted by the slow sinusoidal current if some nerve response has returned, is the best form of treatment.

OBSTETRIC PARALYSIS

Obstetric paralysis is due to an injury of the brachial plexus or one or more of the branches of the plexus at birth. There may be partial or complete tearing away of the nerve roots or a tearing or stretching of the cords of the brachial plexus resulting in a varying amount of hematoma or edema into the nerve sheath. The upper arm type is called Erb's paralysis. A spontaneous recovery is possible if the injury is not too severe. In the lower arm type the paralysis involves the eighth cervical and first dorsal nerves. The prognosis here is not as good as in the former. The earlier treatment

is started, the better. It consists of massage of all the muscles of the neck, shoulder, and arm, and passive stretching to prevent contractures. Childish games that call into play the relaxed muscle groups are of great advantage and children usually respond to that kind of thing. A simple splint helps to keep the weight of the limb off the weakened muscles. The child is encouraged to use the paralyzed arm, the tendency is to favor it. It is sometimes advisable to tie the sound arm to the side, so that the child is obliged to use the affected one. Operative measures are not usually employed until the child is eight or ten years of age, and only if the return of function is very poor or if there is bony obstruction retarding progress.

FACIAL PARALYSIS

Facial paralysis is the result of some disturbance of the facial nerve. The cause may be an injury to the head, as a fracture of the skull, resulting in pressure on the nerve along the course of its distribution, or it may follow a mastoid operation, or the chilling of the muscles and nerves of the face due to exposure in extremely low temperature. The effect varies; sometimes pain accompanies partial or total paralysis of the muscles on one side of the face, more frequently no pain is present, but the muscles of the facial expression are paralyzed. The angle of the mouth is depressed on the relaxed side, and the lips are pulled toward

the side of the face in which the muscles are contracted. Dr. F. B. Granger, of Boston, strongly advocates treatment by electricity as early as possible. If there is much pain, he advises the application of positive galvanism for its sedative effect over the painful area.

Fig. 40.—Left facial paralysis, showing relaxed muscles on left side of face owing to injury of the seventh cranial nerve, resulting in a facial paralysis.

If there is little pain, negative galvanism is used for its stimulative properties. He further states that during the first ten days interrupted galvanism should be used, the polarity depending on which pole gives the greater mechanical response after testing the muscles.

If there is a complete reaction of degeneration the positive pole should be used, whereas with a partial reaction of degeneration, the negative is indicated. After ten days the treatment may be changed and the Bristow coil, the slow sinusoidal current, or interrupted galvanism be used, any one of which will help to encourage rhythmic contractions of the relaxed muscles. He warns against overtiring weakened muscles by giving too much electricity, and says that the treatment by electric stimulus must be guided by the amplitude of contractures, and that lessened amplitude is an indication to stop, whether three or fifty contractures have been given. Electric treatment should be followed by a good finger-and-thumb kneading of the muscles of the relaxed side of the face and gentle tapotement to help to mechanically contract the relaxed muscles, followed by stroking and active exercise. The active exercises are of re-educative nature. The patient stands in front of a mirror and practices closing the eyelids, frowning, and moving the lips away from the contracted side. Any kneading of the muscles on the contracted side is contraindicated, as there is already an increase in tonicity of the muscles on this side. Light stroking, however, may help to relax these hypertonic muscles.

PROGRESSIVE MUSCULAR ATROPHY

Progressive muscular atrophy is due to a progressive atrophy of the lower neurons. The disease is not con-

sidered hereditary. The first symptoms usually show in the muscles of the hand in the thenar eminence and in the interosseous membrane. The disease next creeps up to the wrist, causing a deformity like a claw-hand. The shoulder-girdle is the next step in progression. The prognosis is bad. There is a degenerative atrophy of the neurons in the anterior horns of the gray matter of the cord.

At first the muscles are weak, and then they become flaccid and a paralysis follows. The hips and the thighs may be affected later, but the disease does not usually start in the lower extremities, and it seldom spreads to the legs and feet.

Massage, passive and active exercises are merely palliative. If given in the early stage it may help to keep the muscles in a better condition and so postpone for a time the helplessness following a paralyzed condition.

PROGRESSIVE MUSCULAR DYSTROPHY

Progressive muscular dystrophy is a pseudohypertrophic muscular paralysis; very often the disease is hereditary. There is a progressive atrophy of the muscles, which, owing to deposits of fat, gives to the contour of the limb a hypertrophied appearance. The prognosis is bad. The first symptoms are a weakness in the legs. The patient frequently falls. He has a tendency to sway considerably and has to steady body balance very care-

fully while walking. There seems to be especial weakness in the extensor muscles and in the calf muscles. The thighs are large, but they are weak and cannot maintain the weight of the trunk.

There is no reaction of degeneration present and sensation is not disturbed. The reflexes vary, later in the disease they usually disappear. The process of destruction is a primary degeneration due to inherent nutritional weakness of the muscles. At times there is a talipes equino deformity. The deltoid and upper muscles of the arm are often weak. Treatment aims to improve balance and gait. Active exercises may be given for the extensor groups, which usually are the weakest, and if the extensors of the spine are affected, a corset support may be worn.

CHAPTER X

THE TREATMENT BY EARLY MASSAGE IN CASES OF RECENT INJURY: STRAINS, SPRAINS, DISLOCATIONS

About thirty years ago Lucas-Championnière published his book entitled, "Traitement des Fractures par le Massage et la Mobilization." His teaching was founded on the axiom of Aristotle, "Movement is life." This book was not primarily written to extol the use of massage, but to advocate the reduction of immobilization to the minimum. Championnière was the first advocate to shorten the time of immobilization, his claim being that the soft tissues have to be considered from the start along with the bony union. Sir William Bennett, in his "Massage in Recent Fractures," states that Championnière uses massage as a means of preparing the way for a dose of mobilization. In his article in *The Lancet*, published in London in 1898, Sir William introduces this method, and, although meeting with a great amount of opposition from his medical contemporaries, he practised these same methods in his clinical work at St. George's Hospital, London, and taught them to his students. The wonderful technic of massage used and taught by Championnière and his coworkers has not only made for itself a reputation in

France and the British Isles, but it has earned universal recognition. The same theories that Championnière advocated is the basis of the modern treatment of fractures.

STRAIN

A strain is a rupture or overstretching of muscles or tendons. Rider's "sprain," so called, comes under this heading. There is usually swelling and tenderness about the injured area. If the muscle is ruptured the torn ends are approximated by the application of a bandage or by strapping. This dressing should be done by the surgeon. Rupture may be so complete that operative measures are necessary. Not until the swelling has subsided should gentle passive and active movements, accompanied by mild stroking, be administered to the proximal and distal joints. In a case of severe strain all movements to the joint controlled by the affected muscles should be avoided. Such movements should be postponed until all fear of damaging the repair tissue is passed. Massage of the soft tissues should be followed by assistive and, later, resistive exercises.

There is a condition between a strain and a sprain that is a semichronic irritation of muscles. This usually occurs near the insertion of the muscles. Lawn-tennis arm is an example of this condition, the irritation in this case being usually at the insertion of the pronator radii teres. In the chronic stage ossification of tendons is liable to take place.

SPRAIN

"A sprain is a sudden wrenching or twisting of a joint, a sudden partial displacement of two articulating surfaces, followed by immediate replacement. The symptoms are pain, swelling, heat, discoloration, and usually impaired motion." This is Dr. Douglas Graham's definition of a sprain, and it would be difficult to give a better. In order to treat a sprain intelligently the mechanism of the joint, as well as the art of bandaging, should be thoroughly understood by the operator. In a simple sprain the ligaments are stretched, but not torn, and the synovial fluid exudes into the surrounding tissues. Effleurage will help to dispose of the excess of synovial fluid and prevent the formation of adhesions. If there is a complicated sprain, with torn and lacerated ligaments, tendons, muscles, and even nerves, great care is necessary in administering treatment. Much extravasated blood and lymph is dispersed throughout the tissues; this becomes clotted and in organized form constitutes scar tissue, which, if not disposed of, will bind together the soft tissues, ligaments, and tendon sheaths. Hot packs until the pain is relieved, with early effleurage that soothes the nervous system through reflex action of the sensory and vasomotor nerves, will prove of great value. The part injured should be kept immobile, being firmly supported in a benda or ace bandage until repair has taken place. Bandages should be care-

fully removed, and the injured part should be placed in a position as easy as possible, and slightly elevated to aid the venous flow. Effleurage will help to open up the peripheral blood-vessels and lymphatics and so aid absorption. After the pain has been relieved, the massage may be firmer. Early active movements of the distal and the proximal joints will help to prevent the tendon sheaths from becoming adherent and assists the circulation. Flexion and extension movements should suffice until the more complicated movements are warranted. In a sprain of the ankle-joint care should be taken to discover which side of the ankle is overstretched, in order that movement in that direction may be avoided entirely, as this would only further rupture the already lacerated parts.

Sir Robert Jones' treatment of an inward sprain of the ankle would indicate that if sufficient protective correction is securely maintained, the patient may begin to walk early, the walking acting as continuous massage. For the above his method is as follows: After the intense heat and pain has subsided by means of hot packs the ankle is wound round with several layers of absorbent cotton, and a pad $\frac{3}{4}$ inch wide consisting of half a dozen thicknesses of adhesive tape is placed, sticky side out, over the injured area. The foot is next bandaged firmly in a figure-of-eight bandage, from without inward, the adhesive plaster acts as a pad and also helps to secure constant eversion of the foot. A small rec-

tangular splint is bandaged perpendicularly over the external aspect of the ankle to insure stability. Next, a large comfortable boot is worn with two wedge-shaped pieces of leather placed inside the sole of the foot. The bases of the wedges are on the outer side, so maintaining constant eversion. The exercise involved in walking constitutes a constant massage, and this overcomes the tendency of adhesions and prevents the products of inflammation becoming organized.

If this treatment is used Sir Robert claims that no passive massage is necessary.

If the wrist is sprained and there is no fracture of the carpus, either intense cold, as immersing the hand in a cracked ice container, or hot applications, will help to reduce the swelling and relieve the pain. A firm bandage applied following stroking of the hand and forearm is a good means of dealing with this condition. The patient should be encouraged to move the fingers and so prevent the formation of adhesions of the tendon sheaths.

A sprained wrist is not infrequently accompanied by a fracture of one of the carpal bones, the scaphoid being the most common. A molded plaster anterior "cock-up" splint from the tips of the fingers to the elbow is used. The wrist is held in a position of extension in which the hand is in the "grasp" position. Treatment by gentle stroking may be started within a few days. The bandage may be removed, but the hand should be held in position by the anterior splint (see Fig. 41).

After gentle stroking of the limb the patient should be encouraged to voluntarily raise the fingers from the splint a couple of times after each treatment. The number of times that the fingers are raised can be gradually increased. The end of the first week the splint may be carefully removed at the time the limb is stroked and the muscles kneaded. The wrist should be firmly held with both hands of the operator over the seat of fracture, and the patient asked to perform two or three slow steady movements of flexion and extension of the fingers *en masse*. In two or three weeks, when the splints are finally removed, the wrist will be capable of normal motion. A wrist strap may be worn for a week or so.

DISLOCATIONS

A dislocation is a displacement of two articulating surfaces which requires external manipulation for replacement. If a dislocation is complete, the joint capsule is torn. Muscular spasm is by far the greatest difficulty that confronts the surgeon in the reduction of such cases. This is easily seen if an anesthetic is administered; muscular spasm will disappear as soon as the pain is relieved. Effleurage has been known to reduce spasm through its sedative effect on the sensory nerves. Following the relief of spasm, reduction at times has been accomplished even without the aid of an anesthetic. If the dislocation is not reduced within a few weeks, physiologic shortening of the muscles takes

place. Reduction under these circumstances is almost impossible. In practically every dislocation of the humerus at first the head is under the glenoid fossa. From this position the head presses forward or backward. The subcoracoid dislocation in which the head presses forward is the most common type. There are various methods of reduction for this dislocation. The Kocher method is well known; its principle is as follows: The arm is rotated outward with the elbow flexed; from this position the arm is carried forward on the trunk, the elbow being held closely against the chest and the hand on the side of the affected shoulder is placed upon the opposite shoulder. The retention of the articulating surfaces after reduction depends largely upon the healthy condition of the muscles. Therefore the prevention of muscle atrophy should be the first object in view. Nature will take care of the healing of the joint capsule. The muscles, supplied by the same nerve as the joint, are more liable to waste. If the muscles waste, then the joint becomes lax.

The shoulder-joint is more apt to become dislocated than any other, owing to the looseness of the joint capsule and the shallowness of the glenoid cavity. During treatment the forearm should be supported on a pillow. Massage of the anterior and posterior muscles of the neck is given with one hand, while the other steadies the shoulder by supporting over the acromion process. The pectorals and posterior scapula muscles

and the latissimus dorsi are then effleuraged. On the third day of treatment the gentlest form of passive flexion and extension movements to the shoulder-joint may be given. About the end of the first week all the muscles in the vicinity of the injury may be gently effleuraged. Kneading and mild circumductory movements of the shoulder-joint are next added. In about ten or twelve days after the injury the vigor and length of time of massage is increased. At this time passive movements followed by assistive movements are prescribed in the following order: flexion, extension, rotation, circumduction, abduction, and adduction. Any overhead movements should not be attempted for at least fourteen days after the injury, and should then be performed with great care to avoid redislocation.

Similar treatment to that described above, starting with effleurage and following in a few days' time by pétrissage to the proximal muscles, gradually approaching nearer the seat of injury, is indicated in a dislocation of any joint. Passive and assistive movements to the affected joint should be administered with great care, and daily increased range of motion should gradually be sought until active and resistive exercises are able to be performed by the patient.

CHAPTER XI

THE TREATMENT BY EARLY MASSAGE IN CASES OF RECENT INJURY (Continued)

FRACTURES

A FRACTURE is a rupture in the continuity of the bone involving all the tissues in its vicinity. If the fracture occurs near the joint, there is liable to be further complication of ligaments, tendons, and synovial membrane, and even damage of the articulating surfaces.

Fractures may be classified as follows:

(1) Simple fracture, in which the bone is broken, but not the skin.

(2) Compound fracture, in which the bone and the skin are broken, the bone protruding through the open wound.

(3) Comminuted fracture, in which one or both ends of the bone are splintered.

(4) Multiple fracture, in which the bone is broken in more than one place.

(5) Greenstick fracture, found in children, in which the bone is splintered in part of its thickness, and bent.

(6) Epiphyseal fracture, found in young people before the union of the epiphyses takes place. In this fracture the epiphysis at one end or the other of the bone is separated or displaced.

PATHOLOGY OF FRACTURES

In a fracture, muscles, tendons, blood-vessels, and sometimes even nerves are injured. If the extravasated blood is allowed to become organized it is liable to bind the soft tissues together or to the bone, with or without nerve involvement. Bone repair process goes on immediately after a break occurs. A blood-clot takes place from the outer layer of periosteum, lime salts are thrown off from the connective tissue, and from the inner layer of periosteum osteoblasts or new bone cells are poured out. The blood-clot, lime salts, and osteoblasts coalesce to form provisional callus. This callus bridges over from either end of the broken bone, and so new bone is formed. There are two kinds of callus—ring or periosteal, which is external to the bone; and pin or myelogenic, which is in the medullary cavity of the shaft. Frequently there is an excess of callus, which in time becomes absorbed, a year or even more being sometimes required for this absorption.

The main problem in the treatment of fractures is the correct union of the fragments. "Union, however, must not overshadow function." Every effort should be made for the early restoration of function. There is no branch of surgery in which massage and exercise can be used to greater advantage than here. "Muscle is master of bone." The early use of intelligent massage and exercise should not be overlooked if the best results

are to be obtained. Dr. Cotton, of Boston, says, "The important thing to remember is that bad results, so far as function goes, are more apt to be the result of bad treatment than a result of the injury." Training and experience alone will not suffice in the care of recent fractures. These must be combined with skill, which alone can produce that confidence and delicacy of touch that are prerequisites to any genuine success in this kind of work.

In the care of recent fractures length of treatment, pressure exerted, and range of motion in the joints should all increase very gradually. All treatments should last but a few minutes the first day, and should gradually increase to ten or twenty minutes, according to the part being treated.

UPPER EXTREMITY

Fracture of the Carpal Bones.—One or more of the carpal bones may be fractured, the most common being a fracture of the scaphoid. A sprained wrist is not infrequently accompanied by a fracture of the scaphoid.

The hand is usually put in a molded plaster anterior cock-up splint (Fig. 41) from the elbow to the finger-tips. Kneading and stroking of the hand and forearm may be started toward the end of the first week, although movements of the joints should be postponed for three or four weeks.

Fracture of the Metacarpal or Phalangeal.—A fracture

of any of the metacarpal bones is put in a convex palmar splint in which the wrist is extended in a position of grasp, or else traction is exerted by means of a banjo splint in which one or all the fingers may be included, and constant traction is exerted. A cock-up splint is

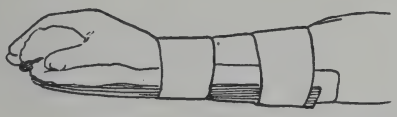


Fig. 41.—Long plaster cock-up splint holding the hand in the position of grasp, as required in fracture of the carpal scaphoid.

sometimes worn with the banjo splint. In fractures of any of the phalangeal bones a palmar splint may be used or a small banjo splint (Fig. 43). Massage of the hand and forearm similar to that used for a carpal

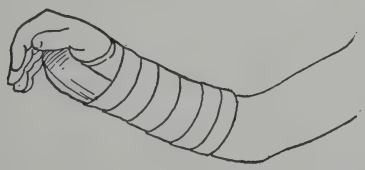


Fig. 42.—Plaster cock-up splint employed in certain cases of injury about the wrist.

fracture should be started very shortly following the injury. If there is displacement, passive flexion, pronation, and supination may be started the end of the first week; if there had been displacement, movements should be postponed for another week.

If there is backward displacement, the hand is frequently put up in a molded plaster splint in adduction; pronation, and palmar flexion, and replaced later by

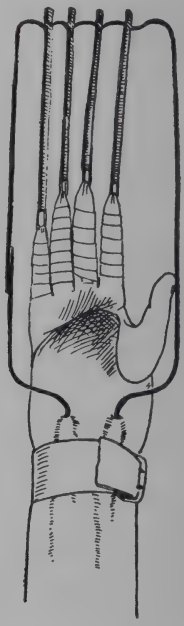


Fig. 43.—Banjo splint (indicated in fractures of the metacarpals with displacement and in certain fractures of the phalanges): The splint is made of a molded plaster strip applied to the forearm, in which is incorporated a wire frame appropriately bent to meet the indication. The traction is obtained by adhesive strips fastened to the fingers and elastic tubing connecting these with the wire frame. One or all the fingers may be included, as necessary.

straight anterior and posterior splints. If both bones of the forearm are broken, an anterior and posterior splint cut to measure the width of the bones of the fore-

arm, with an anterior right angular aluminum splint may be used, or a molded anterior and posterior plaster splint to include the palm, but leaving the fingers free beyond the heads of the metacarpal bones. Treatment by massage should be started in either of the above fractures as early as the surgeon will permit. From the time that the retentive apparatus is applied, the patient should be encouraged to systematically move the fingers five or ten times a day in flexion and extension; this will later insure freedom of the tendons in the fingers and wrist. During the early treatment the forearm and hand are held securely in position by means of the anterior portion of the apparatus upon which the limb rests. The forearm and hand are stroked and kneaded. About the end of the second week the operator firmly grasps the seat of fracture, and has the patient slightly flex and extend the wrist by voluntary movement. Later, gentle resistance may be added. Pronation of the forearm should precede flexion of the elbow-joint.

Colles' Fracture.—This is a transverse fracture of the lower end of the radius with the complication of a sprain of the carpal bones. Frequently the external lateral ligament of the wrist-joint is ruptured, and a small piece of the periosteum is torn from the styloid process of the ulna. In a typical case the hand is displaced backward and outward. The hand is placed very frequently in a plaster cast in the position of adduction,

pronation, and palmer flexion for a week or so; this is replaced by anterior and posterior splints, the fingers being free. (See Figs. 44–46.) The "silver-spoon deformity" was not at all uncommon following a Colles'

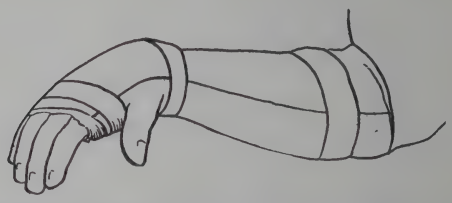


Fig. 44.—Colles' fracture splint: Hand in position of pronation, adduction, and flexion of the wrist.

fracture, although at the present time with the aid of *x*-ray pictures deformities following fractures should be rare. Massage of the hand and forearm may be com-

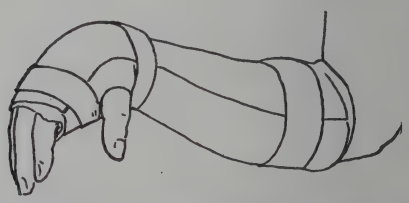


Fig. 45.—Colles' fracture plaster splint, illustrating the extreme position of pronation, adduction, and wrist flexion in which it may be necessary to place the hand after reduction of certain cases of Colles' fracture.

menced as early as the surgeon will allow sufficient of the apparatus to be removed to reach the hand and forearm. The hand should be firmly supported at this time during treatment. The patient is encouraged to actively

move the fingers and the splints should leave the fingers free from the head of the metacarpophalangeal joints. Voluntary and assistive movements are given about the end of the first week. Later resistive exercises take the place of assistive.

Fracture of the humerus may take in any part of the bone, and its location is usually designated as fracture

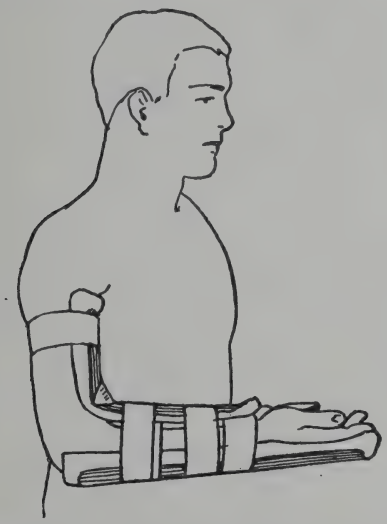


Fig. 46.—Anterior and posterior wooden splints with anterior angular aluminum splint, as used in fracture of the bones of the forearm.

of the shoulder-joint or of the upper, middle, or lower third of the humerus. In a fracture of the shoulder there may or may not be an impaction of the head of the humerus. If there is impaction an axillary or sweat pad may be used, and the arm carried in a sling

(Fig. 49). Another means of treating this fracture is to bandage the arm to the body, using the body as a splint. If there is no impaction of the head, the abduction method of traction by means of a Thomas splint

Fig. 47.—Typical Colles' fracture, showing impacted fracture of lower end of radius and chip off the styloid process of ulna.

or an aëroplane splint is often used (see Figs. 50 and 53). In the impacted head type massage of the muscles of the shoulder and arm and voluntary movements to the shoulder-joint may be started about the third day following manipulation of the muscles. The patient

is asked to gently swing the arm in a forward and backward motion, the operator grasping the arm and supporting the weight at the elbow. In the type with-

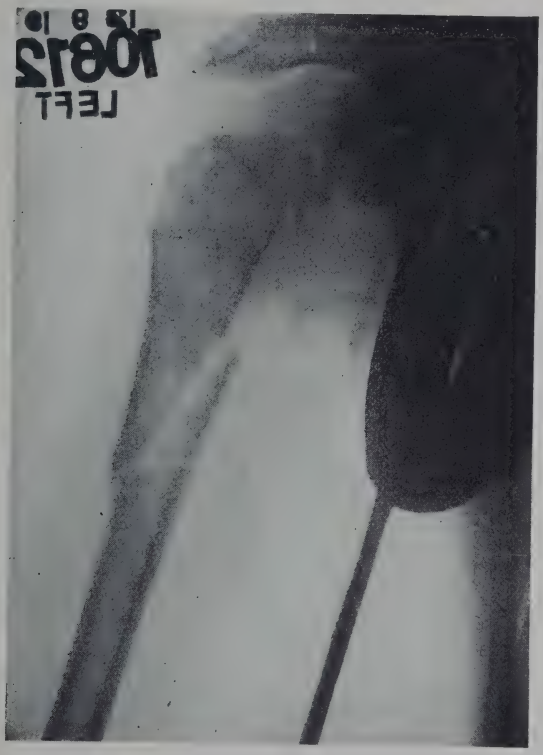


Fig. 48.—Fracture of the upper third of the humerus, including the head, with downward subluxation as a result of the relaxation of the deltoid muscle.

out impaction the recovery is slower. Massage of the muscles of the chest, upper back, neck, shoulder, and arm may be given about the third or fourth day, but

no movement at the shoulder-joint for at least twelve to fourteen days. Then active movements of flexion and extension should be commenced while the operator supports the arm and forearm in the abducted position. If the shoulder spica plaster-of-Paris jacket is used (Fig. 52) it will probably not be removed for massage

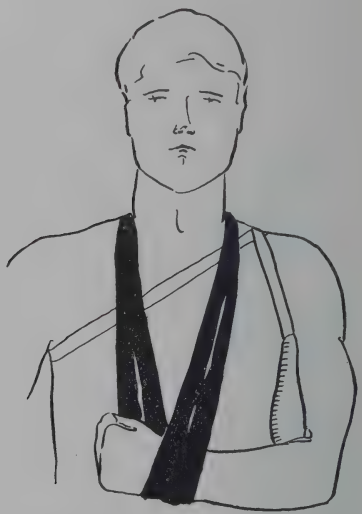


Fig. 49.—Axillary sweat pad and wrist sling, showing the narrow width of the sling.

until about the twelfth or fourteenth day, and then good kneading of the muscles of the chest, back, shoulder, and arm should precede gentle voluntary movements of the elbow- and wrist-joints; voluntary movements of the shoulder had better be further postponed for a

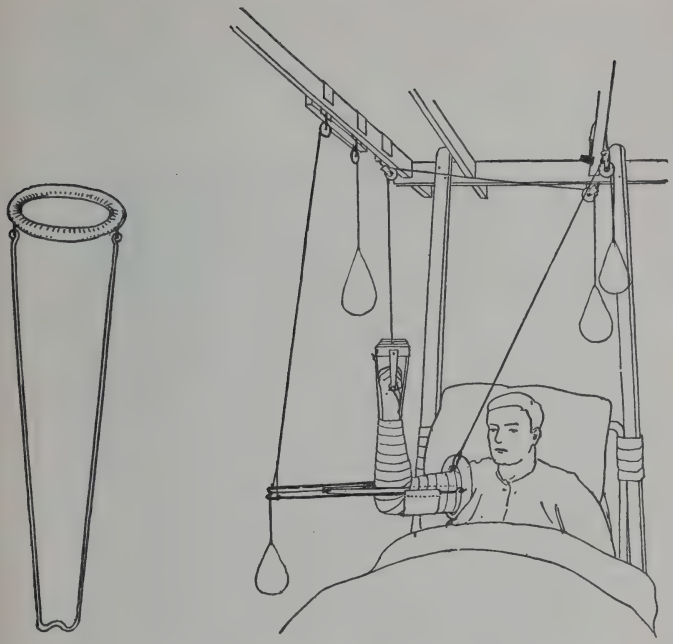


Fig. 50.—Thomas traction arm splint (Murray pattern): The ring is padded with felt and covered with leather and is hinged at its points of junction with the frame. Method of application of Thomas traction arm splint (Murray pattern) in fracture of the upper end of the humerus: Adhesive traction strips are applied to the upper arm, traction being obtained by weight and pulley. The arm is supported on flannel or canvas strips pinned to the side bars of the splint. The elbow may be flexed, as shown, and suspended by means of additional traction strips to an overhead frame; or it may be placed in the extended position, in which case only one pair of traction strips, extending from the wrist nearly to the axilla, is used.

few days at least until the surrounding muscles are in better condition.

Fracture of the middle third of the shaft of the humerus

is sometimes put up after reduction in a Jones humerus traction splint (Fig. 54). The flexed forearm rests within a wire frame on a piece of canvas slung across

Fig. 51.—Fracture of the middle of humerus.

between the sides of the splint. A semicircular cuff fits snugly beneath the axilla and is held in position by means of a sling from the anterior portion of the cuff

Fig. 52.—Plaster-of-Paris jacket, with shoulder spica and forearm casing holding the arm in the abducted position.

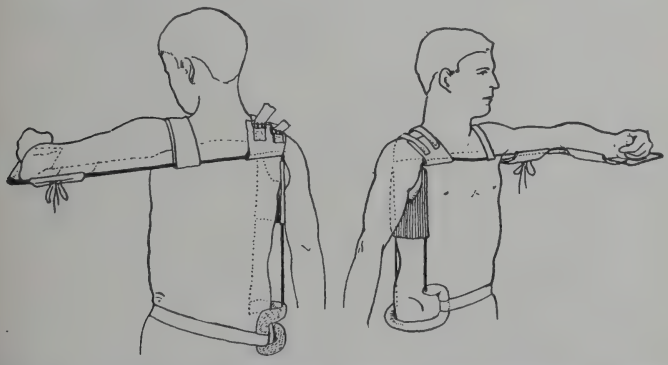
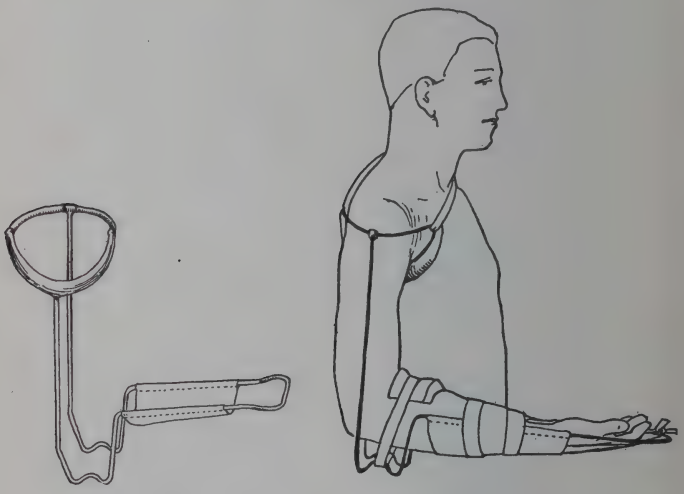


Fig. 53.—Anterior and posterior views of aëroplane splint (Cleary type), the lower support of which rests against the iliac crest.

across the chest, and around the neck, and is attached to the posterior portion of the cuff (Fig. 54). Massage

may be started about the end of the second week. After removing the splint the forearm should be well supported on a padded surface. Stroking and kneading of all the muscles of the hand, forearm, arm, and



A B

Fig. 54.—A, Jones' humerus traction splint. B, Method of application of Jones' humerus traction splint: Traction may be obtained as indicated by means of a strap passing over the upper end of the forearm, in which case a thick felt pad should be interposed between it and the skin. In other cases traction is obtained by adhesive strips applied to the mesial and lateral skin surfaces of the upper arm.

shoulder should be given. Voluntary movements of the elbow and shoulder should not be started for a week or two after the massage. The patient from the start is instructed to use the fingers freely.

Fracture of the Lower End of the Humerus.—After

reduction, the fracture may be put up in various ways according to the details as shown in the *x*-ray picture. Whether the Jones humerus splint, or the axillary pad and sling to the wrist with anterior angular splint are used, it is possible that they be removed in from three to seven days for massage of the muscles of the arm. It is not advisable to start voluntary movements to the arm and shoulder until the seventh or twelfth day, according to the severity of the fracture and the reaction of the muscles following massage.

Fracture of the Elbow.—For a fracture of the head of the radius with or without impaction, but not for ulna fracture (Fig. 56), either strapping the elbow in acute flexion or the right angle splints may be used. A simple method of reduction that works well and which has been used in one large city fracture clinic is to tie up the wrist of the injured arm to the opposite shoulder. The arm lies across the chest and a sling is attached to the wrist and carried around the neck. After ten days in this position the sling is slightly lowered each day until the fourteenth day. The results in practically every case are excellent. No massage is used, but the patient is asked to raise the elbow in its sling toward the mouth three times daily in order to exercise the shoulder muscles and prevent adhesions from forming in the joint. The hand is left free so that there is perfect freedom of the flexors and extensors of the fingers, and at the time the sling is removed there is no stiffening of

the tendons of the forearm. This method of treatment shows so much quicker and better results than the right-angle splinting that its use is bound to gain favor. This matter, however, is entirely in the hands of the surgeon. If the more conservative methods are used,

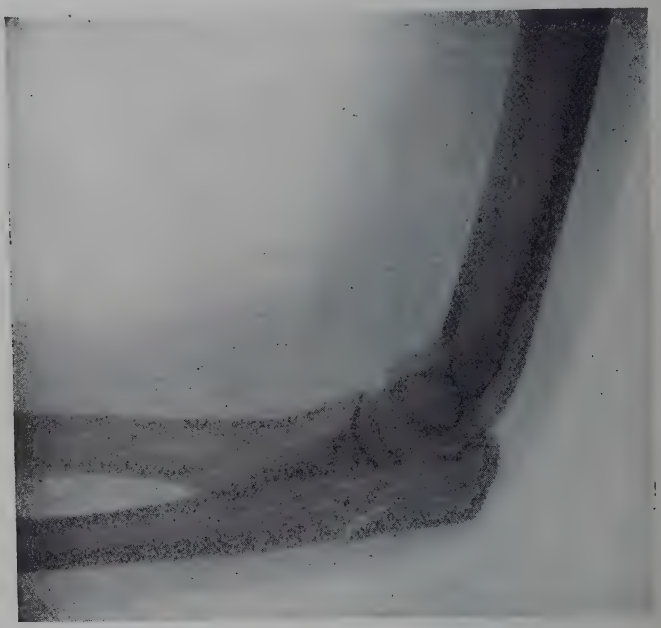


Fig. 55.—Fracture of the olecranon.

massage and voluntary movements may be started in about a week's time following the injury. Active movements of the flexion of the elbow-joint should be fairly well established and should be carried on for about a week before pronation and supination are added.

For a fracture of the olecranon the method of treatment is entirely different. Fixation is maintained in extension by means of a molded plaster splint from the axilla to the palm (Fig. 56). In from seven to ten days the splint may be carefully removed, the limb being entirely supported on a well-padded table. Stroking from the wrist to the palm may then be given, followed

Fig. 56.—Molded plaster posterior splint, holding the elbow in the position of acute flexion.

by gentle kneading of all the muscles of the arm and forearm. From the start the patient is asked to use the fingers freely. If a fragment of the olecranon is broken off, the greatest care should be taken to see that the fragment is not pushed up into the triceps muscle. While kneading the arm it is well to avoid the area over the olecranon. The index-finger of the inactive

hand of the operator may keep guard above the olecranon during the kneading and also at the time the patient first actively attempts to flex the elbow. If

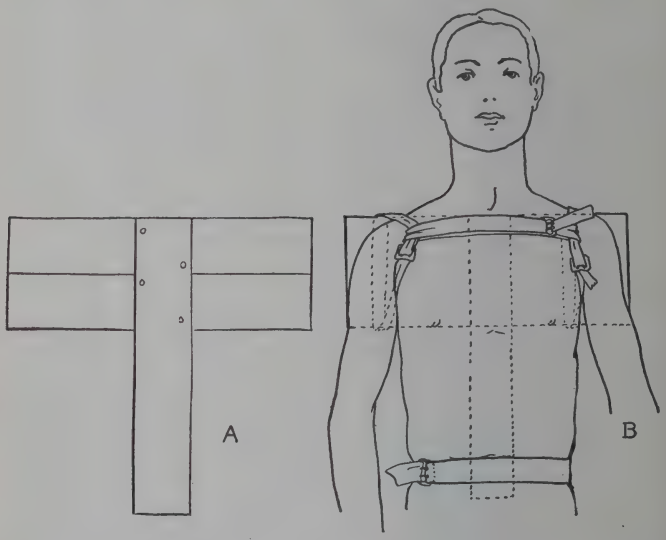


Fig. 57.—A, Clavicular cross (made of splint board), the two pieces, the width of the shoulder, being tacked to a vertical piece reaching from the shoulder to the sacrum; B, method of application of clavicular cross (for purposes of simplification the padding is not shown). The surface of the splint in contact with the skin should be abundantly padded with cotton and covered with bandage. The affected shoulder is lifted up, back, and out and secured to the cross arms of the splint by straps or a figure-of-8 bandage. The lower part of the vertical pieces is pushed in close to the sacrum and held by adhesive or buckle straps.

there is a wide separation of the fragments, and open reduction seems necessary, massage of the muscles of the hand, forearm, and arm is indicated as soon as the

surgeon will allow the anterior part of the apparatus to be removed.

Fracture of the Clavicle.—Splendid results have been obtained by the application of the clavicular cross splint, following reduction (Fig. 57). This treatment is superior to all the older methods of fixation and needs no recommendation. No massage is necessary, for the patient has full range of motion of both arms during the two or three weeks that the splint is worn. After removal of the splint normal movements of the shoulder may safely be advised.

LOWER EXTREMITY

Pott's Fracture.—Pott's fracture is one that involves the lower 3 or 4 inches of the fibula (Fig. 58). In typical Pott's fracture the foot is twisted outward, and there is an overriding of the lower end of the fibula and a rupture of the internal lateral ligament. There may also be a tearing off of the internal malleolus. If local tenderness is present over the internal malleolus, it is an indication of the latter complication. Reduction is necessary only if there is displacement, which is usually the case. In either case the leg is placed in a plaster cast from the toes to the knee, the foot held in dorsiflexion and inversion. A short caliper splint (Fig. 59) is used and a Thomas heel is worn at the time any weight is borne on the limb, as in walking. The inner side of the heel of the shoe is raised $\frac{1}{4}$ inch and it is

extended forward on the inner side under the arch about $\frac{3}{4}$ inch. This is known as a Thomas heel, and keeps the strain off the internal lateral ligament and exerts traction on the lower end of the fibula. Massage

Fig. 58.—Fracture of the fibula (lateral aspect).

of the foot, ankle, and leg muscles will help to hasten absorption and prevent adhesions, and at the same time will help to prevent the extravasated blood and lymph from becoming organized. The massage may be com-

menced within a few days after the fracture as long as no movement of the bones is allowed. The limb should remain in the posterior plaster shell during all massage

Fig. 59.—Thomas caliper splint: The lower ends of the splint fit into the heel of the shoe, and part of the body weight is transmitted to the ground by the direct thrust of the rings against the tuberosity of the ischium. The opposite shoe should be slightly elevated.

for at least twelve to fourteen days. It is possible for the hands to work well around the inside of the shell if the fingers are dextrous. Active movements of

flexion and extension of the ankle should not be started before the fourteenth day, although the patient should move the toes from the start in order to prevent adhesions of the tendon sheaths. An inward Pott's fracture in which the foot is turned inward is put up in

Fig. 60.—Fracture of patella (transverse).

eversion—the opposite of a typical Pott's fracture in which the foot is turned outward. The treatment is much the same in either case except that in the typical Pott's fracture there is more disturbance of the structures and, therefore, the recovery is slower. A simple fibula fracture without displacement, provided it is

held firmly in position, may be used for weight bearing on about the seventh or eighth day.

Fracture of the patella may mean a crack without separation, or it may mean rupture of the lateral expansions of the quadriceps extensor tendon and wide separation of the fragments of the patella. The fracture may be the result of direct violence, in which case the injury is nearly always intracapsular. There is no great amount of separation usually in this type. Operation is seldom indicated if the patella tendon is intact. In the type in which the violence is indirect, if the injury happens when the knee is bent with the patella over the end of the femur, the crack of the patella takes place across the end of the femur and there is a violent pull, causing more or less rupture of the quadriceps tendon. In a fracture without separation the Cabot wire splint (Figs. 61, 62) is applied with the limb extended. No reduction is necessary in either case. Massage of the muscles above and below the knee (especially above) should be started as early as possible. Before active movements are started it is well to teach the patient to concentrate on getting voluntary contraction of the hamstring muscles without movement of the limb. In about a week resistive exercises may be commenced. In order to regain flexion of the knee without much movement over the injured area, the exercises should be carried on in the following way: The patient is seated or reclining with the lower leg extended beyond the

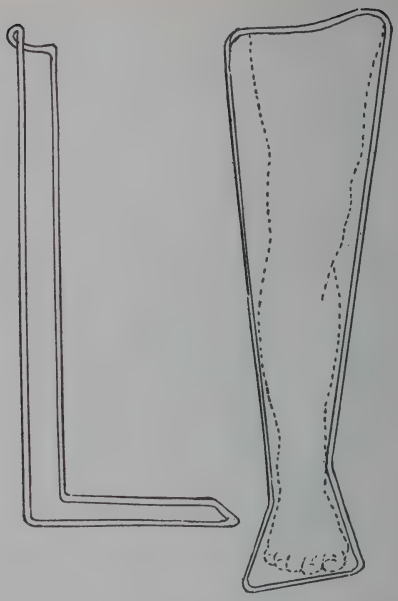


Fig. 61.—Cabot posterior wire splint.

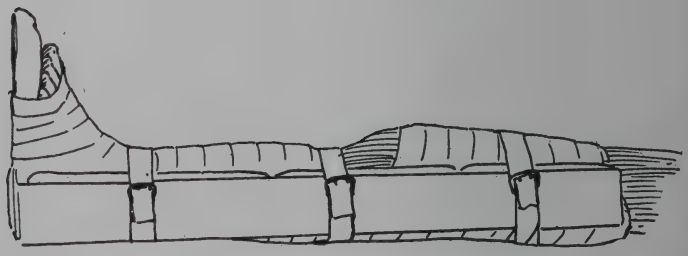


Fig. 62.—Cabot posterior wire splint applied with side splints in injuries about the knee.

edge of the couch. Owing to the extended position in which the limb has been held in the cast the object of treatment is to obtain flexion. The operator grasps

the limb with one hand above the ankle and one hand above the knee and offers graded resistance with the lower hand at the back of the ankle, while the patient is asked to actively flex the knee. In this way the quadriceps muscle is almost isolated from negative or eccentric action, and because the hamstrings are doing the work the injured area is protected. The treatment is much the same both as to fixation and massage and exercises if there is a separation and no operation, except that in the latter case exercises may not be started nearly as early as in the former, perhaps after two or three months. If there is separation, an open operation of suturing the fragments is usually performed, as recovery after operation is so much quicker, although the knee is rarely operated upon until the third to the seventh day following the injury. After the operation a Cabot posterior splint is used and physiotherapy treatment follows as soon as the surgeon will allow, usually in about three weeks' time, and it is carried out in much the same way as that described above.

A *fracture of the femur* may occur at any level of the shaft or near either extremity involving in the upper the head of the femur, and in the lower a separation of the lower epiphysis. Reduction, method of fixation, and time of immobilization depend entirely upon the type and severity of the fracture, the age of the patient, etc. In a fracture of the head of the femur the injury

may be intracapsular or extracapsular. The intracapsular is more common. In elderly people, especially those who have led a more or less sedentary life, spontaneous fracture may occur, but usually there is some pathologic condition responsible for the fracture which was not

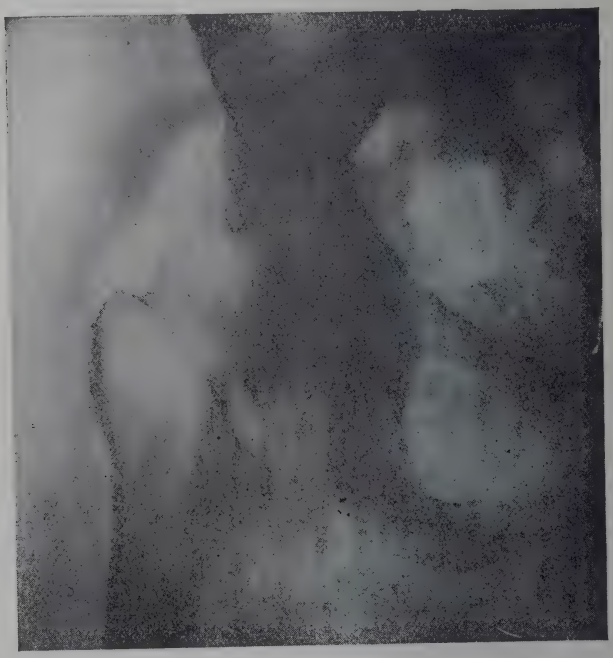


Fig. 63.—Fracture of head of femur (intracapsular).

discovered until an *x*-ray picture was taken. The person may rise rather suddenly, spontaneous fracture taking place, or it may occur at a time when there is no apparent exertion on the part of the patient. Little or no traction is used in these cases. If the muscles

are painful and rigid, stroking has a reflex sedative effect, and quiet deep kneading will help to strengthen the muscles. The reflex arc in older people is easily tired, therefore the treatment should be of short dura-

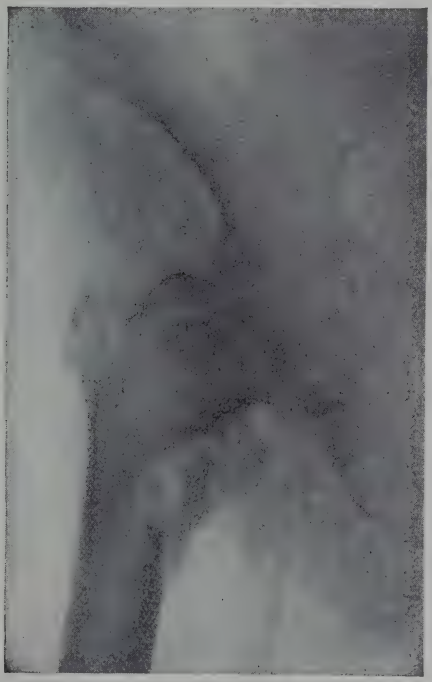


Fig. 64.—Fracture of the head of the femur, showing impaction of the neck (extracapsular).

tion and should aim at relaxation of the muscle groups that control the distal joints before any movements are given. The toes and ankle should be moved voluntarily from the start. It is well to teach the patient voluntary

contraction of the quadriceps extensor group. When the patient becomes accustomed to this exercise the hand of the operator is placed beneath the knee-joint, and the patient is directed to voluntarily contract the quadriceps group, the heel being held by the free hand of the operator. By this means the muscles are slowly re-educated to take up their function. Care should be taken to keep the foot from turning outward. Gentle assistive or passive movements to the hip-joint without body weight is the next step. Later, for re-education of the hip-joint, the patient may stand on the sound limb, at the same time the affected limb may be swung backward and forward several times. Encouragement is necessary for the patient to bear a little weight on the affected limb. This weight bearing is gradually increased and outside support withdrawn. A useful limb is quite possible even in cases of fibrous union fracture. In general, the method of fixation and immobilization varies according to the type of femur fracture.

Physiotherapy treatment is started only when the surgeon deems it advisable to remove a sufficient portion of the apparatus to facilitate such treatment. Stroking and kneading of the muscles of the foot, leg, and thigh may be given at the time that the limb rests in the posterior portion of the apparatus. Voluntary movement of the toes should be encouraged from the start, and the ankle-joint also if the apparatus

will allow of this. The time at which active movements of the knee-joint can be started varies from two to four weeks following the injury. In ununited fractures in which union is much delayed and seems questionable the application of heat in the form of diathermy is being used, and has in a number of cases proved to be of value. Circular metal electrodes are placed not directly over, but above and below the seat of fracture, and from 400 to 600 milliamperes of the d'Arsonval type of high-frequency current is used for twenty to thirty minutes preceding manipulation of the muscles, or the electrodes may be used directly over the seat of fracture, a portion of the fixation apparatus being removed in order to adjust the electrodes. This type of deep penetrative heat brings about an active hyperemia that assists nature in her restorative process of forming provisional callus which later becomes the bond of permanent union.

MYOSITIS OSSIFICANS

The condition known as myositis ossificans is an inflammation of the connective tissue which develops into an osseous growth. This condition is likely to occur in the brachialis anticus muscle following an injury to the elbow, or not infrequently in the quadriceps extensor tendon in the lower extremity. If the spasm is very severe the elbow-joint may be locked. The best treatment for this condition is rest, to be

supplemented by applications of heat and massage. In the majority of cases normal motion of the elbow-joint returns. If the condition is such that it interferes with joint movement, an operation is performed to remove the growth. In the lower extremity if the trouble is not near the knee-joint treatment as above is indicated. If the ossificans is near the joint and liable to interfere with its action after the osteo-proliferation has about completed its growth, in about eight months' time, removal of the ossificans by operation is the only means of treatment for restoration of function of the knee-joint. An *x*-ray picture will show the ossificans clearly defined.

PART II

THERAPEUTIC EXERCISE

CHAPTER I

HISTORY AND DEVELOPMENT OF THERAPEUTIC EXERCISE

THERAPEUTIC exercise is by no means a new form of therapy. Both exercise and rubbing were used extensively in the time of Hippocrates, 460 B. C. Even before this in the far East there was a book written in Chinese about 3000 B. C., called the "Cong-Fu," which dealt with prescribed movements. Hippocrates and his famed teacher, Herodicus, each taught gymnastics for the preservation of health and the cure of disease. It is claimed that Herodicus cured himself of physical defects by the application of his own theories and lived to be one hundred years of age.

Galen, a noted and respected Roman physician who lived from 130 to 200 A. D., was greatly interested in friction, and prescribed exercise. He, like Herodicus, practised his own theories of regular exercise in order to overcome a general physical weakness. He discovered that the arteries were filled with blood in the living body, and not with air, as the Greeks believed, although

it was not until 1628 that William Harvey discovered the circulation of the blood.

Every system of gymnastic training should be based upon a knowledge of the anatomy of the human body and upon the laws which control its function. Gymnastic training should express itself in the perfect control of the neuromuscular actions of the individual. For many years in various countries pioneers in the field of physical development have demonstrated their theories and instituted systems to carry out their ideas. Later the system has been associated with the names of the pioneers and the countries to which they belonged. No greater rivalry has existed than that between the German and Swedish schools. The three founders of the system which is spoken of as German gymnastics were Guts-Muths, Jahn, and Eiselin. Adolph Spiese was responsible for an elaborate structure of school gymnastics. Prominent features of the German system are the use of apparatus—dumbbells, wands, Indian clubs, etc. Music was introduced to control the rate and rhythm of exercises in class work, imitation taking the place of command. The German system makes a strong claim to aim at general culture and not at the culture of one branch. It also makes a prominent feature of the selected class work according to the strength, ability, and age of the individual, and the exercises are begun with simple, easy movements, progressing gradually to a higher degree of instruction.

The Delsarte system belongs to the French school. Emphasis is laid upon the value of muscular action as an interpretation of the person's thoughts. Music and rhythmic exercises are a very definite part of this system. Delsarte did not publish any complete or adequate system of his idea on the subject. His teachings were systematized by his faithful followers.

In 1813 The Royal Gymnastic Central Institute of Stockholm, Sweden, was started by Peter Henry Ling. Since the days of Ling this system has been improved upon by his son, Hjalmar Frederick Ling, Branting, Hartelius, and others. Peter Henry Ling claimed that gymnastics have a rightful place in education, military training, and in medicine. Hjalmar Frederick Ling devoted his life to the study and perfecting of educational gymnastics. He was the instigator of the grouping of exercises known as the "Day's Order" and of definite commands in class work. Accuracy, clearness, progression—these principles and a marked military note are the predominant features of the Swedish school. Although the various systems have contributed valuable material, it is to Peter Henry Ling and the Swedish systematized order that we owe much today in general gymnastic training, and in the field of medical gymnastics or therapeutic exercise.

In America one of the pioneer movements toward forming definite standards of revised physical education took place about the year 1860. This movement was

started largely by the work of Dr. Hitchcock at Amherst College, and was followed later by Dr. Dudley A. Sargent in the Hemenway Gymnasium at Cambridge, Mass., and by Dr. Hartwell at the John Hopkins University, Baltimore, and their co-workers in the various colleges and universities. In the year 1889 a Conference was held in Boston, Mass., presided over by Mr. William T. Harris, LL.D., United States Commissioner of Education. The object of this Conference was to place before educators different systems of gymnastics and to secure discussion of the same with a view to clearly ascertaining the needs of physical training in schools and determining the best method of applying the same. Some of the early pioneers in the field of physical education were: Dr. Claes T. Enebuske, Dr. Louis Colleen, Mr. Nils Posse, M. G., Dr. W. G. Anderson, Dr. E. M. Hartwell, Mr. H. Metzner, and Miss Amy Morris Homans, of Wellesley College, Dr. Alice T. Hall, of Women's College, Baltimore, Dr. Helen Putnam, of Vassar College.

Through the splendid work accomplished by these men and women and others America has developed a system of gymnastic training suited to her own needs. Therapeutic exercise, which is now an important part of physiotherapy, has for its basis much the same fundamental principles as those involved in general gymnastic training. The matter of overfatigue should be emphasized because nerves and muscles which are under

normal require more careful supervision during exercise than approximately normal ones. Progression also is an important factor, and encouragement should not be overlooked. Order by command is oftentimes helpful in individual work and necessary in class work because of its decisive stimulative qualities which encourage spontaneous nerve reaction of a similar nature. In hospital clinics and institutions of a similar character, if types of cases can be classified and patients placed in groups, exercises in class formation may be used to great advantage. Order by command has its place just as much in therapeutic exercises as in educational work. The explanatory part of the order should be clearly spoken and the executive part have force or intensity, except in work of a relaxing nature, such as cardiovascular exercises. Instruction in procuring and maintaining a fundamental standing and sitting position is of primary importance in therapeutic exercise.

The subject of therapeutic exercise is a larger one than has been generally considered. It should not be confined to orthopedics or to any one branch of medicine. The intelligent use of therapeutic exercises is a valuable asset in pre- and postoperative work, in many medical cases, in various types of paralysis, and in cardiovascular conditions. An intelligent understanding of the application of therapeutic exercises used conjointly with massage is of great importance. In

cases of low back conditions improved posture may have a direct bearing on the strain imposed on the ligaments of the low back. In subdeltoid bursitis the time to begin voluntary exercises, such as wall creeping, Indian club swinging, etc., should be understood by the physiotherapist. Harm may be done by applying voluntary exercises too soon; yet undue postponement delays the early restoration of function. Voluntary exercises should replace passive movements, as an indiscriminate amount of the latter may prove harmful. As any medical prescription is changed according to the progress of the patient, so in physiotherapy the same rule is applicable.

There are times when it is better for the patient to work out his own salvation by simply trying to use the part normally. Continual treatment of a purely passive nature actually retards progress, as it keeps the patient dependent on outside assistance. Freedom from this assistance and encouragement in mental and physical independence is very important.

CHAPTER II

PHYSIOLOGIC OBJECTS GAINED BY EXERCISE

Exercise has definite physiologic effects upon the structures of the body and upon its functions. The muscular, circulatory, respiratory, nervous, and digestive systems are directly influenced by exercise, whether it be of a passive or active kind. Passive exercises conserve nervous energy and may be used to great advantage if nervous energy is much under normal. Active exercises are of especial benefit to the muscular system, and may be used if they do not lay too great a tax upon the vitality of the patient. In order to obtain the best results from exercise a period of rest should follow any strenuous activity. A standing posture of rest should be in the least harmful position. Relaxation should not be continually on one side because of prolonged strain upon the ligaments on that side of the body, which results in bad posture. The patient is instructed to change the rest position from one side to the other.

In the muscular and bony systems hypertrophy follows a period of continuous use, and atrophy follows a period of continuous disuse. Increase in the size of muscle means increase in strength. Moderately strong

muscles are necessary for the maintenance of health, vigor, and vitality. Muscles are the executive organs that perform definite physical work. The development of muscles should be to the degree necessary to perform their work with ease. The overdevelopment of muscles is injurious. An increased amount of nourishment is necessary for each additional muscle-fiber. The organs concerned with nutrition adapt themselves to the increased demand. Endurance and vigor are at their maximum if the nutritive demand of the skeletal muscles is no greater than the power to furnish this nutrition. In a well-nourished muscular system much work may be accomplished without causing overfatigue. Poorly developed muscles are found in persons who lead a sedentary life and who do not get plenty of outdoor exercise. The farmer or the outdoor laborer usually acquires sound, healthy musculature. Metabolism is increased by exercise and deep breathing; consequently, there is more and better oxygenated blood to nourish the cells and increase the size of the fibers in the active muscles.

In a person with a well-developed muscular system the bony structure is also better developed. Ridges on bones, which mark muscle attachments, show signs of developed or undeveloped muscles. In conditions in which atrophy from disuse of muscles is pronounced the *x*-ray will show an accompanying atrophy of bone.

In the circulatory system an active muscle forces the

blood through the veins in the direction of the heart during contraction. The veins and arteries are emptied during the contraction of the muscle, and upon relaxation are refilled. These suction and pressure processes are much increased by exercise. The expansion of the arterioles following exercise may be caused by increased metabolism in the active muscles or by a reflex stimulus of the vasodilator nerves. Hasebroek, in his experiments, has proved that resistive exercises have caused a reduction in the blood-pressure notwithstanding an initial rise immediately after exercise. Although experiments by other men have seemed to contradict this conclusion, there are other conditions in the circulatory system which might account for this difference of opinion. When dilatation of the peripheral vessels takes place, an influx of blood from the abdominal and portal veins follows in consequence, so that even more blood will flow into the aorta from the left ventricle.

In the nervous system neuromuscular training incorporates co-ordination of muscle and nerve. The trained gymnast is able to conserve nervous energy, which an untrained person is unable to do. Nerve centers in the brain can be trained to control finely co-ordinated muscle actions, but this requires regular, systematic work. The sensory nerves, by this training, are cultivated to the highest degree of apperception. Because of increased metabolism in the active muscles during exercise there is improved nutrition in the motor

and sensory nerves. The walls of the blood-vessels and the involuntary muscles of the viscera are controlled by the vasomotor nerves of the autonomic system, and therefore the functions of the blood-vessels and of the viscera are improved by increased nutrition to the nerves.

In the respiratory system the beneficial results of systematic, regular exercise upon the respiratory system are very pronounced. Breathing exercises develop the functions of the throat, larynx, and trachea. Chest expansion promotes the development of the respiratory muscles, and is noticeable to a marked degree in persons who are undergoing vocal training, because breathing plays such an important part in this study. The compression exerted in the thorax during deep inspiration and expiration increases the venous and lymphatic flow to the heart. The heart is therefore assisted in its action through the compression caused by deep breathing. The increased activity that accompanies games and sports is beneficial for its physiologic effects. The accessory muscles of respiration are brought into play and deeper respiration becomes necessary. More air is taken into the lungs and more blood is exposed to the air in the capillaries of the lungs, making possible a greater interchange of gases. In this way poorly developed lungs are able to cope with the demand of the body. Frequently tuberculosis develops in persons who neglect this thorough aëration of the lungs, for the

upper lobes are a harbor for the tubercular bacilli. If a patient in whom tubercular tendencies exist is taking breathing exercises, he should be taught forcibly to raise the sternum, for this allows a more thorough aëration of the upper extremities of the chest cavity. The pressure exerted in the thorax by increased respiration is especially beneficial in its suction effect upon the venæ cavæ and the thoracic duct.

In the digestive system the action of the diaphragm is such that during inspiration the diaphragm contracts, and internal pressure is thus exerted upon the abdominal viscera. There should be a continual balance between the systemic and portal systems. If owing to enforced rest or to intestinal trouble congestion of the portal circulation exists, this balance is disturbed. Exercises for the abdominal muscles, along with systematic diaphragmatic breathing, will help to relieve the internal congestion and re-establish the balance. The pressure and relaxation brought about by increased respiration also acts as internal massage upon the liver, stomach, and the rest of the abdominal viscera.

SUMMARY

Systematized exercise exerts a favorable physiologic influence upon metabolism through the physical and chemical changes which are brought about by regular contraction of the various groups of active muscles, thus causing general improvement in the environment of all

the cells in the body. It promotes vascular contraction, which has a stimulating reactionary effect upon the internal organs because of an increased demand for blood. It improves the balance between the accelerator and the inhibitory nerves of the heart, and has a favorable influence upon the strength of the heart muscle itself. It necessitates a more thorough ventilation of the lungs because respiration has been increased. It improves digestion because the digestive secretions are promoted and absorption is encouraged.

CHAPTER III

FUNDAMENTAL AND DERIVED GYMNASTIC POSITIONS; A DAY'S ORDER

EDUCATIONAL gymnastics is adapted to the approximately normal individual, and therapeutic gymnastics is adapted to the abnormal. The student who is expecting to use therapeutic exercise to the best advantage should have some fundamental knowledge of the principles which are the basis of gymnastic training. The nomenclature of the Swedish system is reduced to a minimum in this book in order that the student who is not acquainted with that system may be able more easily to use the tabulated exercises. Preventive exercise, in which the incipient form of some pathologic condition may be dealt with, is the most satisfactory kind of therapeutic work. Although each patient requires individual study and attention, there are times in which it is not only possible but of great value to group the different types of cases. In hospital clinics and similar institutions classes may be formed of patients suffering from general debility, foot weaknesses, convalescing empyema, spastic paralysis, and cardiovascular disturbances. Before describing the fundamental and derived positions some rudimentary definitions

of gymnastics and certain directions relative to conducting classes may well be given.

In Gymnastics, "a movement" is a change of position or posture. Bodily movements while primarily related to joints, will also influence other structures and their functions, such as the internal organs and glands.

"A position" is a posture assumed by the body from which certain movements are performed.

"An exercise" consists of a group of certain specified movements executed either at will or by command. The execution of a command brings the body into one of the fundamental or derived positions. "A command" in gymnastics is divided into two parts with a pause between.

1. The explanation, in which the activity is clearly and briefly defined.

2. The command, which should have force or intensity except when used for exercises the object of which is relaxation, in which case the command should be given without force or intensity.

All commands should be given in a well modulated voice and in clear tones. Between the first explanatory part and the command itself there should be a pause of sufficient duration for the explanation to be clearly understood. For example: "Hands on hips"—pause—"Place."

FUNDAMENTAL GYMNASTIC POSITIONS

There are five fundamental positions in Swedish gymnastics—standing, sitting, kneeling, lying, and hanging.

In the *fundamental standing position* in educational gymnastics the heels are held together, the toes forming an angle of not more than 45 to 60 degrees. The knees and hips are fully extended; the head is erect, the chin is drawn in, the chest is well lifted, and the arms hang in contact with the lateral aspect of the thighs. The elbow-, wrist-, and finger-joints are in a position of extension. In medical gymnastics the same body posture is assumed, but the feet are placed parallel. The fundamental standing position and the training of correct posture in sitting and walking plays an important part in therapeutic exercise.

In the *fundamental sitting position* the patient sits with the whole of the thigh supported. The hip-, knee-, and ankle-joints are kept at right angles, the feet on the floor, and the legs slightly apart. The head and trunk are held the same as in the fundamental standing position, the arms hanging by the sides.

In the *fundamental kneeling position* the patient kneels on the floor or on a low plinth, with the knees and feet held close together, and the feet plantar-flexed. The head, arms, and trunk are held the same as in the fundamental standing position.

In the *fundamental lying position* the person lies on the back; the legs are kept close together; and the arms

are held close to the sides, so that the whole of the body is supported.

Fig. 65.—Fundamental standing position.

In the *fundamental hanging position* the person grasps a bar, boom, or fixed apparatus; the feet do not touch

the ground, and the body is suspended. The hands should be a little more than shoulder width apart and are pronated while gripping. The arms, legs, and trunk

Fig. 63.—Fundamental lying position.

are fully extended, the head is held erect, and may be slightly thrown back. The chest is well lifted.

DERIVED GYMNASTIC POSITIONS

Positions taken from any of the fundamental positions are called derived positions, and are obtained by changing the position of the arms, by changing the position of the legs, or by changing the position of the trunk. A combination of the derived positions denotes progress.

Some Derived Positions from the Fundamental Standing Position

I. By changing the position of the arms:

Wing or hips firm standing. The hands are placed on the hips, fingers forward, and thumb backward. The elbows are carried slightly backward.

Rest or neck firm standing. The finger-tips of each hand are placed on the nape of the neck, finger-tips

Fig. 67.—Derived position by changing the position of the arms. Bend standing (*A*). Arms upward bend.

Fig. 68.—Bend standing (*B*). Arms forward bend.

touching each other. The head should be erect and the elbows held well back.

Bend standing (Figs. 67, 68). (*A*) The arms are placed

in *the upward bend position;* the forearms are placed against the arms, which remain by the side of the trunk. The elbows should be held as close to the sides as possible (Fig. 67). (*B*) The arm is placed in *the forward bend position;* the forearm is flexed on the arm,

Fig. 69.—Derived position by changing the position of the trunk. Trunk forward bend 45 degrees.

which is in a horizontal plane with the shoulders (Fig. 68). The bend stand is the initial position from which all arm stretchings are taken.

1. *Reach standing.* The arms are stretched forward, shoulder width apart, elbows extended, palms facing.

2. *Stretch standing.* The arms are stretched upward, shoulder width apart, elbows fully extended, palms facing.

Fig. 70.—Two derived positions from the fundamental standing position: by moving the legs; by changing position of arms.

3. *Yard standing.* The arms are stretched sideward at shoulder height, elbows fully extended, palms downward.

From the above forward, upward, sideward standing positions, arm circlings and arm flingings are taken.

II. By changing the position of the legs:

Close standing. The feet are parallel, inner borders touching.

Fig. 71.—Three derived positions from the fundamental standing position: foot placing; arm raising; trunk twisting.

Stride standing. The feet are moved sideward, about two foot lengths apart, and are parallel in therapeutic exercise. The stride stand position makes a wider base,

and is therefore an easier position for the patient than the close standing position if derived trunk movements are being performed. Other derived foot positions are:

The forward.

The backward.

The forward outward.

The backward outward.

Toe standing or heel raising. The heels are raised from the ground, being kept in contact with each other.

Knee bend standing. The knees are flexed and separated. A combination of knee bend with heel raising is commonly used.

Fall out standing. The right or left leg is placed three foot lengths forward. The knee is bent until it is directly above the toes. The reverse leg is kept in the fully extended position, and there should be a straight line from the heel to the head. The shoulders should be level and square to the front.

III. By changing the position of the trunk:

Stoop standing or trunk bending forward. Flexion of the trunk to an angle of 45 degrees takes place at the hip-joints. The knees are fully extended and the spine is kept straight (Fig. 69).

Lax stoop standing or trunk bending forward downward. Flexion of the trunk at the hip-joint with the knees fully extended, the vertebral column bending upon itself and the arms hanging loosely forward.

Arch or backward bend standing. The trunk is bent backward, extension chiefly taking place in dorsal region.

Turn standing. The body is turned or twisted to one side or the other as far as possible without changing the relative positions of the head and shoulders.

Derived positions by changing the position of the arms, by changing the position of the legs, and by changing the position of the trunk are similarly obtained from the fundamental sitting, lying, kneeling, and hanging positions.

A SWEDISH DAY'S ORDER

A day's order means that every muscle in the body is exercised without fatiguing any group at any time. In this order, special emphasis is placed upon exercising the extensor groups. In the ordinary activities the flexors are more used than the extensors. Hjalmar Ling was the instigator of this method of using a progressive schedule of exercises for the various muscle groups of the body. He worked out this formula from the theories of his father, Peter Henry Ling. This schedule of exercises for various muscle groups is the back bone of Swedish educational gymnastics, and is useful in therapeutic exercise, either for class work or in planning an individual program of exercises. The following revised day's order is suggested. It is divided into 7 groups instead of the 11 which made up the original groupings. Numbers 1, 2, 3, and 4 cover general train-

ing. Number 5 is for local effects; 6 and 7 finish with general.

1. Stimulating interest and attention. (Marchings, facings, hand and foot placings.)

2. Large muscle groups. (Slow arm and leg activities.)

3. Upper trunk (respiratory). (Arch flexions, hanging.)

4. Balance activities. (Knee bending, heel raising.)

5. Trunk muscles (thoracic and abdominal).

6. Precipitant activities. (Effects are increased heartbeats and increased respiration, that is, a general physiologic effect.) Jumping, swinging, vaulting, running.)

7. Slowing down of respiration (with arm raisings and stretchings).

CHAPTER IV

POSTURE TRAINING; EXERCISES FOR GENERAL DEBILITY; ABDOMINAL EXERCISES

POSTURE TRAINING

General debility is likely to be accompanied by a condition known as "poor posture." This is very often caused by an overtired condition of the nervous system, and signifies disordered balance of muscle action. Normal function of the nerves that control the voluntary and the involuntary muscles is lacking. The skeletal muscles, supplied by the cerebrospinal nerves, and the abdominal viscera, supplied by the splanchnic nerves of the autonomic system, are all liable to be affected.

POSTURE WORK

There are definite recognized types of poor posture. The fatigue position, as it is termed, is often the first stage of relapse. In it the head and neck are stooped forward, and the upper portion of the trunk sinks backward. The usual secondary condition is a compensatory one in which there is relaxation of the abdominal muscles accompanied by an exaggerated lumbar curve. The normal angle of pelvic inclination is from 50 to 60 degrees. (Fig. 72, A, B). This inclination is increased in the

exaggerated lumbar curve type, and the pubic arch is tilted too far downward. Another type of poor posture is known as the obliterated curve. In this the lumbar spine is too flat and the body weight is placed

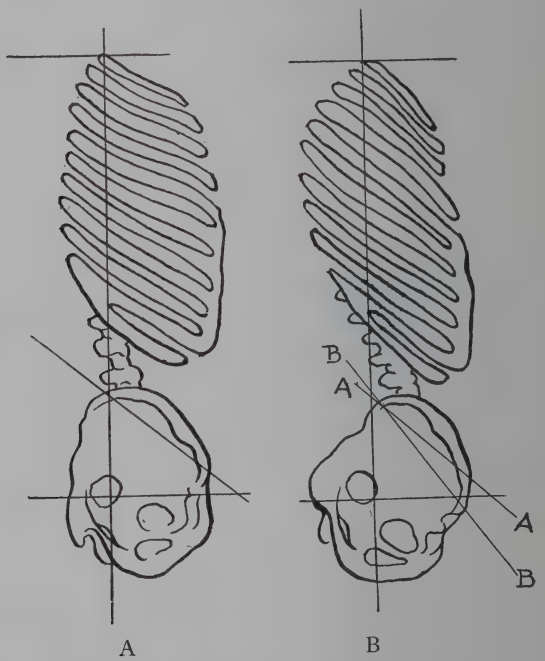


Fig. 72.—A, Normal pelvic inclination. B, Abnormal pelvic inclination.

too far back on the heels. The pelvic angle of inclination is decreased and the pubic arch is tilted too far upward. It is not uncommon to see children when asked to stand up straight assume what is known as the bantam position. This is the result of a mistaken effort

to raise and expand the chest. The shoulders are raised also, and the result is a stiff and unnatural posture which cannot be held for any length of time. In any type of poor posture there is a change in the normal anteroposterior line of the body, some part or parts being carried too far backward or too far forward.

Another type of poor posture is one in which there is slight lateral deviation. In this there is a change in the lateral aspect of the spine which may or may not be accompanied by a change in the anteroposterior aspect. The defects of this type viewed posteriorly show one shoulder lower than the other, and the horizontal line of the hips to be uneven. In severe cases this condition involves a twisting of the spine with rotation of the vertebræ, and is known as scoliosis. It is discussed in ChapterVI, Part II, and does not belong to postural defects.

Large double mirrors are used for posture training. This training should precede exercises given for the development of the anterior and posterior trunk muscles. Photographs showing the appearance of the figure at the start of the treatment have proved to be of value because they demonstrate in a more evident manner than words the existing conditions which the patient should endeavor to overcome. If the photographs can be renewed after two months' training, it is helpful both to the patient and to the instructor, and serves as a record of improvement.

Treatment should first aim to correct the body mechanics if at first complete rest and relaxation are not prescribed. The cause of the debilitated condition should be sought and corrected if possible. Prescribed rest, out-of-door exercise, and plenty of sleep are helpful, in combination with physical therapeutic treatment. A daily tonic—hydro treatment—is excellent if it is available. A warm needle-and-spray shower, followed by an alternate hot-and-cold douche up and down the spinal column, preceding a general massage and special exercises, make an excellent prescription.

Posture training should be the first lesson taught. The understanding and co-operation of the patient is necessary from the start. The feeling of "correct posture" cannot be too strongly emphasized, and an effort should be made to develop the "posture sense" in the mind of the patient.

If visceroptosis is pronounced, the assumption of the knee-chest position is highly recommended by eminent physicians. A derived knee-chest position to be assumed after meals for from five to fifteen minutes once or twice daily is sometimes prescribed to aid impaired digestion and relieve the strain of sagging from the abdominal organs. It may be carried out as follows: The legs from the hips are supported on a firm couch, the trunk and head inclined downward, the head resting on the hands which are supported on a cushioned stool or low chair. The downward inclination from the hips

to the chest should be sufficient to enable gravity to offer assistance in restoring the normal position of the abdominal viscera. As an adjunct to exercises and positions some support is advised, such as a corset without restriction around the waist, but with a firm uplifting pull around the lower part of the hips. The corset is at times reinforced with an abdominal pad attached inside, the pad resting upon the pubic arch, and so adjusted that when the lower part of the corset is laced it pushes up the abdominal organs and helps to keep them in their normal position.

We are continually faced with the problem of poor posture, both in children and in adults. How to attack the problem depends entirely whether one is dealing with the prevention of poor posture in its early stage among children in school, or the correction of poor posture of children attending hospital clinics. The American Posture League has organized an excellent method for dealing with school children. It consists of the triple test and grouping system. The triple test judges the posture of the child in standing, walking, and in exercises. The test is repeated for the entire class once a month. Each child is considered as an individual unit and marked according to his merit in the first or second division. The vertical line test is used in which the three segments of the body, namely, (1) head and neck, (2) trunk, (3) legs, correspond to one vertical line. The attainment of this vertical line

Fig. 73.—Good posture. Head erect, chin in, chest well raised, shoulders drawn back and down, and body weight falling on the balls of the feet.

test places the child in Division 1. The grouping system which separates Division 1 from Division 2 has a strong psychologic effect and makes an appeal

Fig. 74.—Poor posture, showing sunken chest, exaggerated lumbar curve, and body weight falling on the heels.

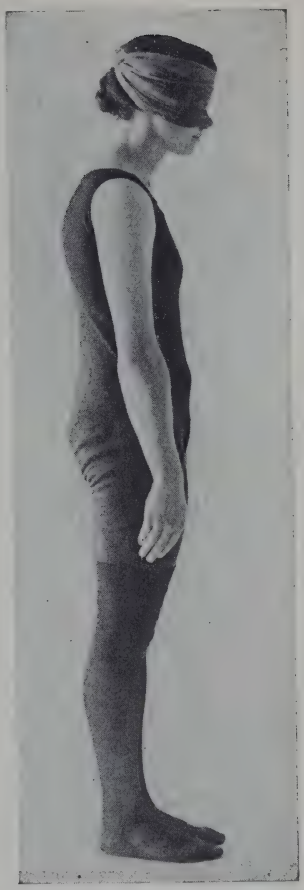


Fig. 75.—Second type of poor posture, showing the obliterated lumbar curve.

to the child for promotion to the good posture division. The children in Division 2 claim a greater amount of time and attention from the teacher. Each child

is taught how to attain correct posture without strain or exaggeration. Following the preliminary individual teaching the child is placed in a posture drill class. Next follow special exercises for the scapulæ, lower back, and abdominal muscles. The assumption of corrected posture is emphasized throughout the special muscle training. School-room habits are watched and checked up in connection with the posture work.

Hospital clinic work among children may be carried out on much the same general principle. The addition of a gold or silver star to be attached to the individual posture card of the child acts as an incentive. In one hospital clinic that is doing excellent work in this field the child is asked to lie down for twenty minutes at home twice a day in the hyperextended position. The patient lies flat on the back with a blanket folded into a roll and placed under the shoulder-blades. This allows expansion of the chest. The head drops backward for correction of the posterior neck muscles. How conscientiously home work of this sort is carried out depends entirely upon the co-operation and encouragement of the parents. The child reports each week at the clinic and is encouraged to work for the attainment of the silver star which is presented as a reward for the results accomplished. If the silver star is won, visits to the clinic are less frequent, every two or three weeks. A gold star is another step in advance and is the goal toward which the child works. In

order to see that no bad habits of posture are resumed, it is advisable that the child report to the clinic in two months' time.

In dealing with children in individual work the writer has found that telling a story of the building of a house analogous to that of building correct posture is helpful because it claims the child's interest and attention from the outset. Preceding the instruction in correct posture the measurement of the chest is taken at the level of the top of the ensiform cartilage which should be two-thirds in the anteroposterior plane to that of the lateral in a normal chest. A flat chest has a smaller anteroposterior measurement, and a pigeon chest has an almost round anteroposterior measurement. To carry out the analogy of a house, the first consideration in the structure is the foundation. The body weight is to be carried on the balls of the feet and not upon the heels, and the base to start is rather wide, so the feet are parallel and 6 to 8 inches apart. As progress is noted, the feet may be moved closer to-

Fig. 76.—Weight carried on balls of feet. Arrow A indicates anterior uplift. Arrow B indicates posterior uplift.

gether. The uprights in building a house are erected before the walls, therefore they receive next consideration. Raising the chest corresponds to the anterior uprights, and pushing up on the crown of the head to the posterior uprights (Fig. 76). This anterior and posterior uplift raises both the chest and the spine and corrects the alignment of the head and shoulders with the trunk. Exercises for the abdominal muscles, lower back, and scapulæ regions correspond to the building of the walls after the erection of the framework, when good body alignment is understood. Breathing exercises are commenced just as soon as corrected posture is capable of being maintained for a few minutes at a time.

EXERCISES FOR IMPROVEMENT OF GENERAL MUSCLE TONE

The following two sets of exercises will give some idea of a day's program if general muscle building is desired. Number 1 is a simple program. Number 2 is more complicated and is better suited for advanced work. Posture training should precede all active exercises and should be thoroughly grasped and maintained while standing, sitting, and walking. In the preceding exercises the question of whether the patient is able to maintain the corrected position throughout the exercise is an important one. Two possible errors to be avoided are the sway back position when the arms are in upward extension position, and also hyperextension

of the knees when an effort is made to hold the corrected position. No overhead arm raisings or stretchings should be attempted until control of the body alignment is within the person's power, and then emphasis is laid upon keeping the good alignment.

Schedule No. 1:

(*a*) Standing, arm raising sideward, head bending backward, inhale; return arms and head to postion, exhale.

(*b*) Standing, with hands on hips, alternate right and left knee upward bending, and stretchng forward, and return to position. (Five times each.)

(*c*) Standing, arm bending, upward stretch, clasp hands above head, jumping, return arms. Speed to increase heart beat. (Ten times.)

(*d*) Standing, hands placed on chest at about level of ninth rib, slowly inhale, exhale. (Ten times.)

(*e*) Individual sits on stool, arms forward bend. Operator stands behind patient, with right knee to foot resting against the back of patient. Operator grasps elbows, and with upward, backward movement, rotates the arms, at the same time pressing forward with knee. (Ten times.) (Fig. 77.)

Schedule No. 2:

(*a*) Standing, arms rotating outward, inhale. Arms return to position, exhale.

(*b*) Hanging with back against stall bars, overhand grasp. Alternate right and left knee bending, keeping lumbar spine flat against bars. (Five times each.)

Fig. 77.—Passive stretching for pectoral muscles with counter-pressure given by knee of operator.

(*c*) Standing, arm raising forward, upward, inhale; sideward, downward, exhale. (Ten times.)

(*d*) Arms forward raising (grasping 2-pound dumbbells), sideward stretching. (Ten times.)

(*e*) Lying, lumbar spine flat, alternate right and left

straight leg raising, return slowly to position. (Five times each.)

(*f*) Lying, hands on hips. Trunk bending, right and left alternately. (Five times each.)

(*g*) Standing, arm forward bending, and sideward flinging. Speed to increase heart beat. (Twenty times.)

(*h*) Standing, exaggerated stretching posture; rise on toes, arms sideward raising, inhale. Heels sink, arms return to sides, exhale. (Ten times.)

ABDOMINAL MASSAGE AND EXERCISES

There are no remedies so efficient as natural ones for constipation. Care of the diet, plenty of active out-

Fig. 78.—Patient in position for abdominal massage with knees slightly flexed and supported by pillow.

door exercise, regular habits of living, and drinking plenty of water make a simple but effectual prescrip-

Fig. 79.—Trunk raising upward from fundamental lying position, feet held by operator, for strengthening the abdominal muscles. The hands may be placed on hips or behind head.

Fig. 80.—Supine lying position, knee upward bending, lumbar spine kept against plinth.

tion. In cases of long standing abdominal massage accompanied by special exercises are beneficial. It is

easier for the operator to stand or kneel (arms parallel with the abdomen) when giving an abdominal massage.

The procedure consists of a circular transverse kneading of the intestines. The operator stands preferably at the right side of the patient, placing the two hands side by side on the abdomen, which is rolled, first with the thenar eminence pushing toward the left, then the fingers together pushing back to the right. This rolling

Fig. 81.—Leg lowering slowly, keeping lumbar spine flat.

should be given for several minutes with the two hands side by side, and followed immediately by circular kneading. This is started at the right-hand corner of the abdomen and is carried along the ascending, transverse, and descending colons, continuing for several minutes. Firm stroking follows the kneading along the same circular localized parts, particular attention being paid to the hepatic and splenic flexures. Kneading

may be given directly over the portion of the liver not covered by the ribs. Beating also may follow over the right and left lobe of the liver given with the ulnar border of the closed hand. Vibration has a stimulating effect upon the intestines. This is best administered by placing the cupped hand upon the center of the abdomen, using a slight vibratory movement with downward pressure, which is relaxed and repeated consecutively about every five seconds for one or two minutes.

EXERCISES FOR VISCEROPTOSIS AND CONSTIPATION

1. Lying, diaphragmatic breathing (knee bend position, feet resting on plinth). (Ten times.)

2. Lying, right knee bend, clasp hands over knee and press it against chest, extend knee and return leg slowly to position, repeat exercise with left knee. The lumbar spine should be kept down against plinth throughout the exercise. (Five times each leg.)

3. Sitting, hands on hips, trunk circumduction. (Three each way.)

4. Sitting, toe support, trunk reclining backward and raising. (Two times.)

5. Standing, hands on hips, heel raising, knee bending. (Ten times.)

6. Standing, arm raising sideward, with deep breathing. (Ten times.)

7. Lying, hands on hips, feet held by operator, rise to erect position. (Three times.)

8. Stride standing, throwing medicine ball, using the lateral trunk muscles for several minutes.

9. Lying, keep lumbar spine flat, raise both legs (knees fully extended) as high as possible, return to position. (Three times.) (This exercise should first be practised with single leg raising and lowering before double leg raising is given.)

10. Modified knee-chest position maintained for three minutes, gradually increasing time to ten or fifteen minutes. The legs from the hips are supported on a firm couch, the head and trunk inclined downward. The head should rest on the flexed forearms which are supported on a low cushioned stool or low chair. The downward inclination from the hips to the head should be sufficient to enable gravity to offer assistance. (This position is recommended in cases of severe visceroptosis.)

Some physiologic objects gained by abdominal massage and exercises are given below:

1. They stimulate the liver and gall-bladder.
2. Aid digestion in the stomach and intestines.
3. Relieve constipation by increasing peristaltic action.
4. Promote absorption of fluid by elimination through kidneys in case of ascites.
5. Cause absorption of fat deposits.
6. Strengthen weak and relaxed abdominal muscles.
7. Break down adhesions.
8. Mechanically assist in moving on the contents of the colon.

CHAPTER V

KNOCK-KNEE; FOOT DEFORMITIES; FOOT WEAKNESSES AND THEIR TREATMENT BY MASSAGE AND EXERCISE

KNOCK-KNEE is a congenital condition in which there is an inward bending of the femur and tibia. This inward trend of the structure allows relaxation of the ligaments and fascia on the inner side of the knee-joint. Providing that treatment is commenced in early child life (the earlier, the better), a great deal of improvement in cases of the milder type is possible. Daily rubbing and stretching of the limb while the child is in the bath-tub is excellent. The warm water softens the tissues and daily systematic rubbing and stretching for several consecutive months is necessary in order to accomplish results. Firm manual pressure should be exerted over the inner side of the knee-joint, at the same time the lower part of the leg just above the ankle is grasped and pulled inward against the counterpressure on the inner side of the knee. This helps to stretch the ligaments and fascia on the external aspect of the knee.

Foot deformities may be congenital or acquired. In most instances those of the acquired type are the result of diseases in childhood. For example, the equinovarus condition which not infrequently follows infantile paral-

ysis. If there is much structural change in the bones, and subsequently an adaptive overstretching and shortening of muscles and tendons, then an operation is usually the only method that will obtain favorable results.

Foot weaknesses in which the trouble rests principally in the muscles and tendons are often very successfully treated by physical therapeutic methods. The cause of the condition should receive first consideration. If necessary, shoes especially fitted to assist in overcoming the pernicious tendency should be obtained. Kneading of the foot and leg muscles, followed by passive, active, and positive resistive exercises taken daily for several weeks, will prove advantageous. The patient should be warned to resume practice of the corrective exercises and positions from which benefit was derived if signs appear of a recurrence of the trouble.

ANATOMY OF THE FOOT

The American Posture League describes 3 distinct types of the normal foot: (1) The outflare, (2) the inflare, and (3) the straight.

"The foot should be not merely a passive support, but an active organ of locomotion." The outline of the normal foot presents a triangle with its apex toward the heel, and the broad part of the triangle at the toes. The weight of the body is distributed between the three points: (1) The heel, (2) the base of the little toe,

(3) the base of the great toe (Fig. 82). The toes should normally be straight and capable of plantar flexion and extension, the great toe having freedom in dorsiflexion. Normal range of motion in dorsiflexion of the ankle-joint should be 70 to 80 degrees, with the knee extended and the forefoot inverted. Less than 90 degrees signi-

Fig. 82.—A, Outline of a normal foot presents a triangle with its apex toward the heel, the broad part at the toes. The weight of the body is borne upon the three points of the triangle. B, Outline of a flat-foot.

fies a shortening of the tendo achillis, which is a sign of potential foot weakness. The movements of pronation and supination are principally in the subastragaloid joint, the mediotarsal joints being free in all directions, but especially in adduction and abduction. Inversion and eversion of the whole foot are produced by pivoting the foot upon the heel. Inversion is the result of the

action of the tibialis anticus and posticus muscles; eversion is the result of the action of the peroneal longus and brevis muscles. In a normal foot the adductors are approximately 25 per cent. stronger than the abductors. If the abductors are stronger than the adductors an acute flat-foot condition is present. The short plantar ligament lies between the sustentaculum tali of the os calcis and the scaphoid. It acts as a supporting medium for the head of the astragulus. The two natural arches of the foot are known as the longitudinal and the transverse. Neither are true mechanical arches, as neither have a fixed point at each end, therefore they are supported by means of muscles, tendons, and ligaments. The longitudinal arch is seen from the inner aspect and extends from the anterior part of the heel to the distal end of the first metatarsal bone. The highest portion of this arch corresponds to the highest point of the scaphoid bone. The transverse arch is formed by the distal ends of the metatarsal bones. A slight convexity is seen from the dorsum of the foot and a corresponding concavity on the plantar surface. The highest point of the transverse arch is over the second and third metatarsal bones. A plumb-line may be used for testing abnormal positions of the foot in relation to the leg. Anteriorly, one end of the string is placed in the center of the patella, and the weight at the other end of the line should fall over the interosseous membrane of the second and third toe. Pos-

teriorly, one end of the line is placed in the center of the popliteal space, and the weight should fall to the middle of the heel.

FOOT DEFORMITIES

Foot deformities cannot be treated by massage and exercise with satisfactory results. If much structural change exists and the possibility of a serviceable foot is out of the question, an operation is frequently performed to meet the individual needs of the case. Following operation correction is maintained by means of a plaster cast. At the time

Fig. 83.—Hallux valgus. Enlargement of the first metatarsophalangeal joint.

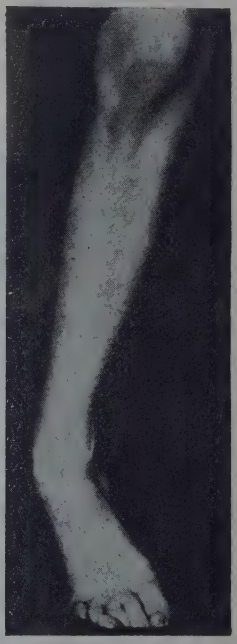


Fig. 84. — Talipes varus with equino deformity in which the patient walks on outer border of foot with heel drawn up.

Fig. 85.—Talipes valgus, in which the patient walks on inner border of foot.

Fig. 86.—Talipes calcaneo, in which the patient walks on the heel, also showing clubbed toes.

the cast is removed massage of the limb and exercises of a re-educational nature are beneficial.

In a hallux valgus there is an enlagement of the metatarsophalangeal joint. A patient having a talipes varus deformity walks on the outer border of the foot. A talipes valgus is just the reverse of varus, causing the patient to walk on the inner border of the foot. The patient with a talipes calcaneo walks on the heel. In a talipes equino the heels are drawn up during walking. A pes cavus condition is one in which there is a hyperlongitudinal arch.

FOOT WEAKNESSES

Anterior Metatarsalgia.—The transverse arch of the foot is formed by the heads of the metatarsal bones. Normally, the transverse arch of the foot should be slightly concave on the sole, over the heads of the second, third, and fourth metatarsophalangeal joints. The tendon of the peroneus longus muscle passes under the tubercle of the fifth metatarsal bone and extends on the plantar surface to the great toe, thus acting as a support for the transverse arch. If metatarsalgia is present, the arch becomes convex, the tendon losing its power of support. Pain occurs across the dorsum of the foot. Callus is usually present on the plantar surface over the heads of the metatarsal bones owing to the sagging of the heads due to lack of normal muscle support. Massage of the foot and leg is given, with spe-

cial attention to the plantar surface, in which the short flexors of the toes are overstretched owing to a convexity of the transverse arch. The most beneficial exercise for this condition is that in which the patient stands with

Fig. 87.—No. 1 of triple exercise for anterior metatarsalgia.

the heads of the metatarsal bones resting upon a board of wood about 1 inch in thickness, the toes being stretched forward and downward to reach the floor. The effect of this exercise is strongly to contract the overstretched

muscles on the plantar surface of the foot and at the same time raising the transverse arch (Fig. 87).

A felt pad strapped transversely and fitting snugly just at the back of the heads of the metatarsal bones will give temporary relief. This may be used until the

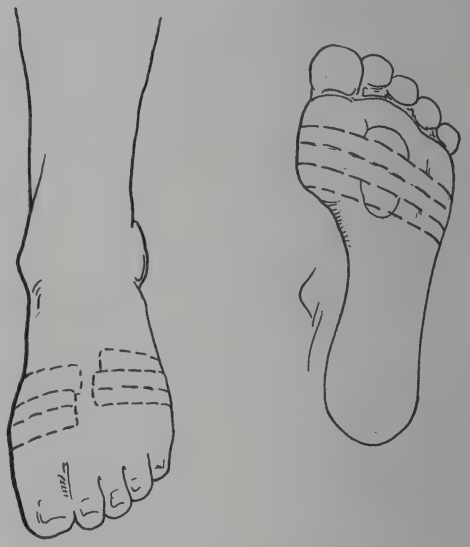


Fig. 88.—Anterior metatarsalgia pad.

plantar muscles regain their function so that the arch may be maintained by voluntary muscle action.

Flat-foot is the most common form of foot weakness. It may be caused by the wearing of faulty shoes or from getting overtired, especially if the person is stout and the muscles of the foot are not well developed. The wearing of an entirely different kind of shoe or a

sudden change from a sedentary life to one that calls for excessive use of the feet may be the cause of flat-foot. A combination of these causes is not at all uncommon.

Fig. 89.—Anterior view of flat-foot.

Flat-foot may be divided into three classes: Those in which the trouble is chiefly in the early stage of muscular weakness; those in which structural deformity is imminent; those in which bony deformity is present and often of long standing. Cases of the first type usually

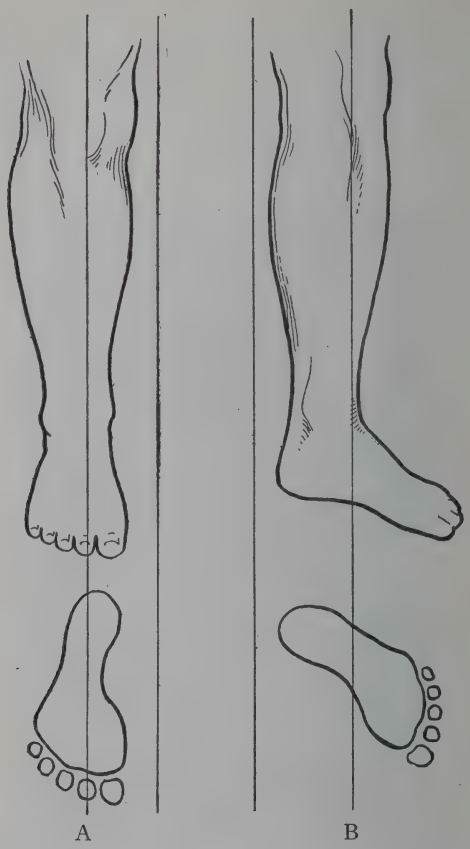


Fig. 90.—A shows the normal straight line of the leg and foot, weight bearing being evenly distributed between the three points. B shows a flat-foot, outward position of the forefoot, with weight-bearing strain imposed upon the weakest part of the foot—the center of the arch.

improve if treated by an alternate hot-and-cold foot bath once or twice daily, followed by massage of the plantar muscles, the calf muscles, the peroneal and

anterior tibial muscles, and by kneading of the thigh muscles. At first passive, then active exercises, later adding graded resistance for the toes and ankle-joints are given, inversion is emphasized, and eversion is omitted entirely. Even after a few treatments the pain is

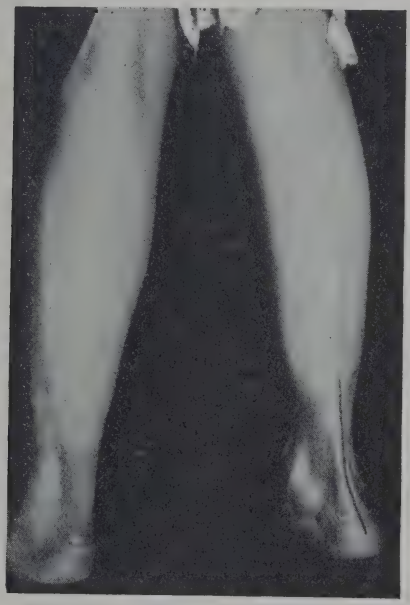


Fig. 91.—Posterior view of flat-foot.

relieved, and improvement almost always follows as a result of improving the muscle tone.

In the second type, if inflammation of the tarsal bones is present, hot packs and absolute rest are necessary, with no body weight borne on the feet until all signs of inflammation subside. Passive and later posi-

tive resistive exercises (see Chapter II, Part I) to the toes and ankle-joint are given, particular emphasis being laid upon inversion of the ankle. All the exercises for this type of flat-foot should at first be given while the patient is in the lying position without weight bearing. Exercises in the standing, sitting, and walking positions may be taken as the condition of the foot improves. (See list of exercises at the end of the chapter.)

In the third type, if much bony deformity is present, massage and exercise are of little benefit, although corrective exercises have sometimes proved of value. In all cases of flat-foot the patient should never attempt to walk without having the heel of the shoe adjusted. Stress should be laid upon the necessity of wearing the Thomas heel, in which the inner side of the heel is raised from $\frac{1}{8}$ to $\frac{1}{4}$ inch, the inner side of the heel extending forward so as to support the plantar ligaments. Any outside foot support should be used merely as a brace and should be discarded at the earliest opportunity, as soon as the muscles are re-educated and ready to function alone. In cases of the first and second types the muscles should be trained to take up their natural action by the aid of regular graduated exercises in standing, sitting, and corrected walking.

At the completion of the above-described treatment, if the patient is obliged to be on the feet a good deal, the application of adhesive strappings for a few days is sometimes used to assist in overcoming the tendency

to pronation. A small felt pad is placed on the inner side of the heel. The first strap passes from above the external malleolus, under the heel covering the pad,

Fig. 92.—Showing application of the first two straps, foot inverted, and position of pad when strapping for flat-foot.

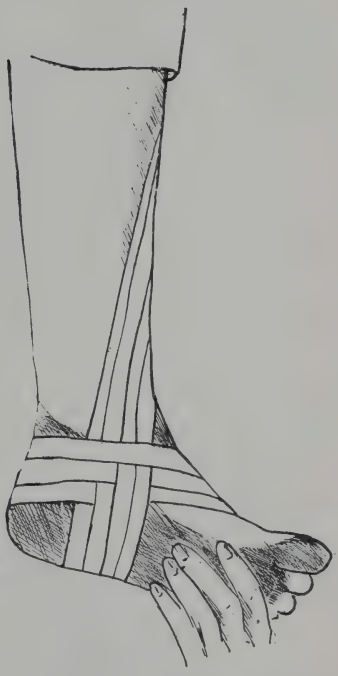


Fig. 93.—Showing the final position of the straps, internal aspect.

and is pulled tightly over the sole and the internal malleolus so that the foot is adducted and inverted. The second strap is placed transversely to the first and four or five straps each way are fixed alternately in

the order described above. The longitudinal straps are about 12 to 14 inches long and about 1 inch wide, and the transverse straps are 8 to 10 inches long and 1 inch wide. If support during the time of foot muscle re-education is considered necessary, it should be fitted

Fig. 94.—Showing final position of straps, external aspect.

to the person by whom it is to be worn. A plaster imprint of the foot is taken and a light weight support made from the mold. A ready-made support can hardly be expected to supply the individual needs of every customer. The support is sometimes worn for several

weeks or months, therefore it is imperative that a correctly fitted support be worn. Persons having foot weakness should be advised to carefully consider well-fitting shoes. For practical every-day purposes a straight inner line shoe with a fairly low good-sized heel is good. Care should be taken not to make any radical change in the shape of the shoe, but rather, with the aid of corrective exercises, temporary support if necessary and slow progression gradually accustom the foot to a well-balanced shoe which at its widest part gives room for the broadest part of the foot.

The following list of exercises embraces training for weakened adductor muscles and invertor muscles, also for a short tendo achillis. It is recommended that about four exercises be picked out and practised daily. The program in this way can be changed from time to time and avoid monotony. It is frequently necessary to continue exercises for weeks and even months if the condition is severe.

FOOT EXERCISES

Sitting:

1. Legs below the knee extend over end of table, plantar flex the toes and relax, bringing them back each time to the straight position. This exercise brings into play the intrinsic muscles of the plantar surface of the foot (Fig. 95). (Five times.)
2. Same position as in 1. Draw foot inward so that

the sole can be seen. This exercise develops the adductors and invertors (Fig. 96). (Five times.)

Fig. 95.—Number 1 of triple exercise. Plantar flex toes.

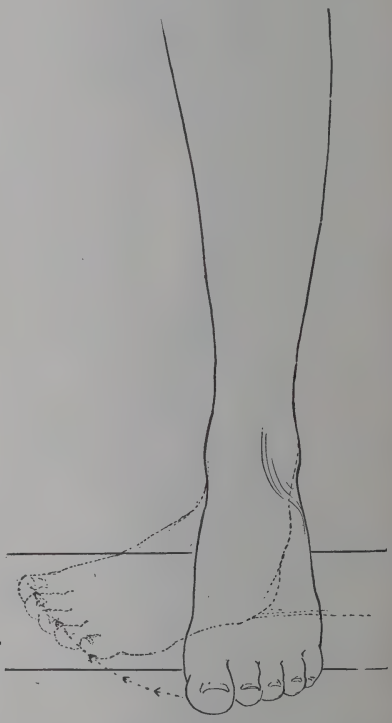


Fig. 96.—Number 2 of triple exercise. Adduct foot from the straight line position.

3. Same position as in 1. Dorsiflex the ankle. This exercise brings into play the dorsiflexors (Fig. 97). (Five times.)
4. Combine the above three, making one exercise

known as the "triple exercise" (Fig. 98). (Five times.)

Fig. 97.—Number 3 of triple exercise. Dorsiflex ankle.

Fig. 98.—Combine No. 1 plantar flex toes—hold. Number 2 adduct foot—hold. Number 3 dorsiflex ankle—hold.

5. Sitting on chair, knees abducted, legs crossed, rise, bearing body weight on outer border of foot, hold while counting five. This brings into play the adductors and invertors. (Five times.)

6. Sitting on floor, knees apart, throw and catch tennis ball with the soles of the feet. This exercise brings into play the tibialis anticus and posticus.
7. Sitting on chair, feet parallel, about 12 inches apart, grasp a heavy bath towel with the toes of the right foot and draw towel inward, holding the heel firmly in the original position. Repeat with the left foot. (Five times each foot.)
8. The preceding exercise can be done, using both feet together. If the muscle pull comes from below the knee, it brings strongly into play the intrinsic plantar muscles, the adductors, and invertors. (Ten times.)

Standing:

9. Patient stands in front of mirror, bearing the body weight on the outer edge of the foot, with the knees slightly rotated outward.
10. From the above corrected position the feet are placed 4 inches apart, the body weight on the outer edge, the toes held in plantar flexion, count five. Return to corrected standing position and repeat five times. This exercise aims to instil a sense of corrected foot position.
11. Hands on hips, place. Toe in, rise on toes; slowly transfer weight to outer border, then to heels. This exercise uses the foot muscles, but especially the bow strings that support the longitudinal arch. (Five times.)

12. Towel exercise. Same as in sitting position. As a means of progress, a 1- or 2-pound weight may be placed at the further end of the towel so that the muscles have to work against resistance.
13. Stand facing the wall, more than arm's length away. Lean forward and rest hands on the wall, keeping the knees straight and the heels down on the floor. This exercise stretches the tendo achillis. (Five times.)

Walking:

14. Hands on hips, walk on a straight line so that the heel of the forward foot touches the toe of the back foot. The body weight should be borne on the outer border. This exercise is for balance as well as for overcorrected walking.
15. Walk on outer border of foot, toes turned in.
16. Practice straight held foot position. "Indian walk."

CHAPTER VI

SPINAL CURVATURE: EXERCISES FOR KYPHOSIS AND LORDOSIS; THERAPEUTIC EXERCISES FOR WEAKNESS OF BACK MUSCLES

SPINAL CURVATURE

THERE are four natural curves in the normal spine. Two are called primary curves, and two secondary. The child is born with a dorsal and sacral convexity from the posterior aspect. The cervical curve appears when the child learns to extend the head. The lumbar curve shows signs of appearance when the child begins to walk. If the natural curves are increased, reversed, or the spine as a whole deviates from the straight line, a pathologic condition occurs which is known as spinal curvature. In general, there are three forms of curvature of the spine—the kyphotic, in which there is an increased upper dorsal convexity posteriorly; the lordotic, in which there is an increased lumbar convexity posteriorly; and the one in which there is a lateral deviation of the spine. Spondylitis, or Pott's disease, in which there is inflammation of the vertebræ from tubercular or other causes, may be the occasion of the curvature. In any type of caries of the spine the patient is usually placed in a cast in order that rest may fa-

cilitate the subsidence of the inflammatory processes. Manipulation and exercise are strongly contraindicated in such cases.

Fig. 99.—Kyphosis and lordosis, showing sunken chest and sagging of the abdomen.

Kyphosis.—In kyphosis or round back there is an exaggerated backward convexity of the normal dorsal curve. The head and shoulders are held in the forward stooped position and the chest is contracted. Kyphosis

is usually the first position of slump posture, and in its early stage develops a stretching of the posterior neck and scapulæ muscles. Later the bony framework adapts itself to the muscular change. The ribs are lowered anteriorly and imperfect support of the shoulders result from this change, and the inferior angle of the scapula is rotated outward. (See Fig. 72, B.)

Lordosis.—In lordosis, or hollow back, so called, there is an increase in the normal lumbar curve accompanied by a lack of balance between the lower back and the abdominal muscles. The normal inclination of the pelvis is between 50° and 60° (Fig. 72, A). (See Fig. 72.) This angle is taken by means of a straight line drawn between the hip-joints known as the principal diameter. The conjugate diameter cuts the principal diameter, forming an angle of between 50° and 60°. The conjugate diameter is considered from the crest of the pubis to the top of the sacrum (Fig. 72, B). The pelvic angle of inclination in lordosis is beyond the normal and frequently the knees are hyperextended. (See Fig. 72, B.) Lordosis may occur as a secondary condition to kyphosis or it may exist without any other change in the anteroposterior aspect of the spine. The treatment either for kyphosis or lordosis is, first, posture training as described in Part II, Chapter IV. Especial emphasis should be directed to maintaining corrected posture throughout the program of exercises which should follow.

THERAPEUTIC EXERCISES FOR KYPHOSIS, LORDOSIS, AND FOR INCREASING THE FLEXIBILITY OF THE SPINE

I. *Exercises for Kyphosis:*

1. Supine lying on plinth with a small hair pillow placed between the shoulder-blades, hands behind neck, fingers touching. Operator stands at head of patient

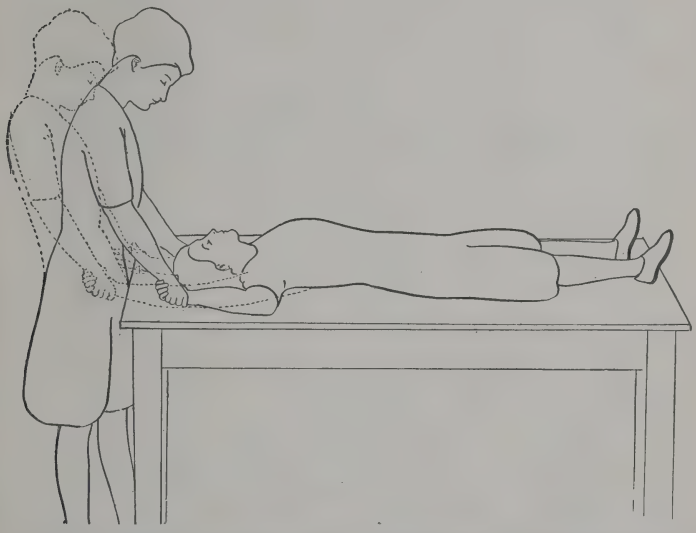


Fig. 100.—Passive exercise against resistance for strengthening the scapulæ muscles.

and passively stretches the chest by pressing the elbows down upon the plinth. (Five times.)

2. Supine lying, arms extended above head, operator grasps hands and offers resistance while the patient pulls the arms down flat against the plinth, elbows flexed, until the arm lies flat against the sides of the chest (Fig. 100). (Five times.)

3. Sitting on stool, feet well apart, hands behind head. The operator standing behind the patient presses the right flexed knee against patient's back. The operator grasps the elbows, and at the same time a rotary passive movement is given to the arms, the knee is

Fig. 101.—Passive stretching for pectoral muscles with counterpressure given by knee of operator.

pressed against the back. (This counterpressure gives a strong passive stretch to the pectoral muscles—Fig. 101.) (Five times.)

4. Standing, arms extending forward and stretching sideways and backward at shoulder level while operator

stands behind, offering graded resistance at the back of the forearms. This exercise brings the rhomboidei and the levator scapulæ into play.

5. Exaggerated good standing position, arms sideward raise, hand turning, inhale. Return arms to sides, exhale. (Ten times.)

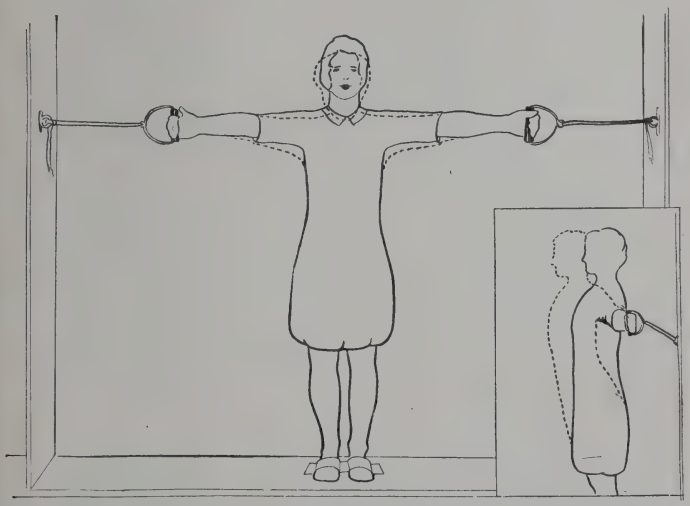


Fig. 102.—Handles and ropes attached to uprights at shoulder height for strong voluntary stretching of the pectoral muscles.

6. Chest expansion by stretching the pectoral muscles. A simple and exceedingly good exercise for stretching the pectoral muscles is to have a pair of handles attached to an upright on each side by means of a rope. The rope may be of any length, but should be attached to the uprights at the level of the shoulders. The patient extends the arms sidewards and grasps a handle in

each hand, the arms being fully extended when the grasp is taken. For the pectoral stretching the patient sways forward from this position, and the body weight

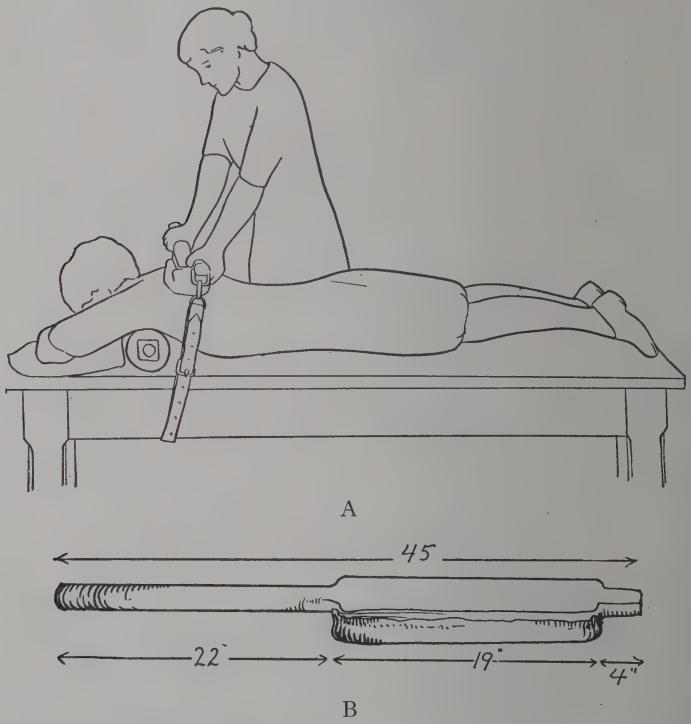


Fig. 103.—Paddle apparatus exercise for increasing flexibility in rigid spine: A, Operator exerting pressure with paddle. B, Paddle, as used in A.

is used as resistance against which the pectoral muscles are stretched (Fig. 102).

7. Exercise prone lying with paddle (see Fig. 103, A),

operator presses down on paddle the amount that can comfortably be borne by the patient; he then relaxes pressure and repeats exercise five times. The pressure and number of times should gradually be increased. (For rigid dorsal spine only.)

II. *Exercises for Lordosis:*

Types:

1. Lying touching the floor with the lumbar vertebræ, hold, count 5, relax, and repeat fifteen times.

Fig. 104.—Exercise for lordosis. Lying hips and knees flexed, extend knees and raise pelvis from the floor until body rests on upper part of back.

2. Standing against wall, touching wall with buttocks and dorsal spine, and attempting to touch with lumbar spine. Measure the distance of feet from wall, endeavor to maintain position and get feet nearer the wall.

3. Single knee bending, stretching upward and lowering, counting 10. (Five times.)
4. Double knee bending, stretching upward, and lowering slowly. (Five times.)
5. Single leg raising and lowering without bending the knee, attempt strongly to

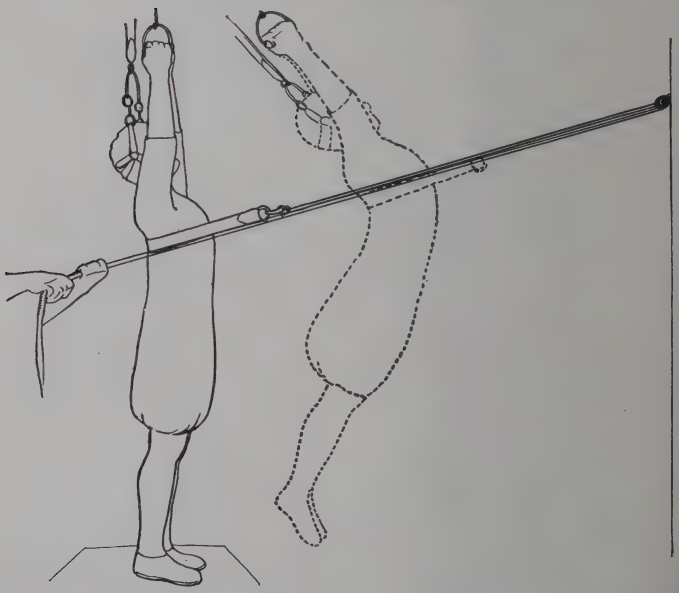


Fig. 105.—Head sling and McKenzie apparatus for gaining flexibility in rigid dorsal spine.

keep the lumbar spine on the floor. (Five each.)

6. Double leg raising and lowering without bending the knees. (Five times.)
7. Long sitting position legs fully extended, hands behind neck, raise chest, inhale

lower chest, exhale, but do not relax the trunk from the hips. (The long sitting position helps to overcome the swayback in lordosis.) (Ten times.)

8. Supine lying, both hips and knees flexed, hands flat on floor; from this position

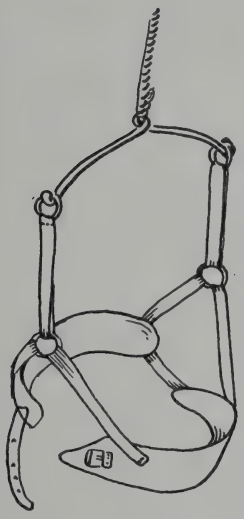


Fig. 106.—Head sling, as used in all head suspension exercises and in combination with the McKenzie apparatus (Fig. 105).

raise both legs to the perpendicular (knees fully extended) and then carry legs beyond the head so that the body weight rests on the scapulæ (Fig. 104). (Once or twice only.)

III. *Exercises for Increasing the Flexibility of the Spine:*

Types:

1. Head circumduction. (Five to right, five to left.)
2. Head flexion and extension. (Five times.)
3. Head side flexion. (Five to right, five to left.)
4. Stride standing, arms stretching sideward, trunk bending forward and downward, raise slowly, holding back straight. (Five times.)
5. Stride standing, trunk bending forward 45 degrees, arm flinging from arm forward bend position. (Ten times.)
6. Stride standing, trunk bending forward, touching floor without bending knees. (Two times.)
7. Body turning from reach standing position, two people grasping hands work up speed. (In rhythm.)
8. Trunk twisting, from trunk bending forward. (Five times.)
9. Trunk circumduction. (Five times.)
10. Stride standing, arms stretching sideward, trunk twisting. (Five times.)
11. Stride standing, arms stretching sideward, trunk bending sideward, alternately right and left. (Five times.)

12. Sitting astride stool, hands on hips, trunk twisting. (Five times.)
13. Sitting trunk bending sideward. (Ten times.)
14. Hanging from stall bars, climbing stall bars rapidly.
15. Head suspension from head sling feet raised from floor.
16. Standing, trunk twisting from side to side very rapidly.
17. Long sitting, legs fully extended, trunk bending forward.
18. Swinging on double rings, body circumduction: (*a*) Lifting feet from floor. (*b*) With feet on floor.
19. Paddle exercise (see Fig. 103). (Start with five times and increase times and pressure described in Chapter VII, Part II.)
20. Head sling combined with McKenzie apparatus described in Chapter VII, Part II (see Fig. 105). (Start with two and increase to twenty.) The last two exercises are excellent in cases of dorsal rigidity.

CHAPTER VII

SPINAL CURVATURE (Continued): EXERCISES FOR LEFT TOTAL CURVATURE; EXERCISES FOR SCOLIOSIS (RIGHT DORSAL LEFT LUMBAR)

LATERAL curvature or scoliosis is a condition in which there is flexion, sidebending, and rotation of the vertebræ on their vertical axes. In the kyphotic and lordotic types of spinal curvature the deviation is of an anteroposterior character, but in scoliosis the deviation is also lateral. Scoliosis is too frequently not discovered until much structural change has taken place in the spine.

The causes of lateral curvature are obscure. It is generally considered that predisposing factors in postural curves are astigmatism, general constitutional weakness, and faulty positions of posture. A true scoliosis in which structural change has taken place may be considered from two standpoints, one in which cast and exercise are indicated and one in which physiotherapy is contraindicated. Disease of the spine comes into the latter class and will not be considered. An old spinal meningitis, infantile paralysis, or a congenital spinal abnormality may be the predisposing cause of the curvature. The bilateral muscles that maintain the equilibrium of the spinal column lose their balance, so that contraction of the erector spinæ group takes place on one side of the column and stretch-

ing on the other side. Owing to the strain of this irregular muscular action the spinal column bends, yielding to the pull of the contracted muscles. Lateral bending may be either to the right or left, and may take place in the cervical, dorsal, or lumbar regions.

SINGLE CURVE

A single, total or C-shaped curve, as it is sometimes called, may extend the whole length of the spine. A single curve is more prevalent to the left curve than to the right. This is at times the incipient stage of a double curve. At this stage the spinous muscles are chiefly affected. The ligaments are next in order to give way. This results in the bones losing their natural support and, in consequence, there is displacement of the structure.

DOUBLE CURVE

A true scoliosis has rotation of the vertebræ along with lateral bend. Hippocrates (460 B. C.) described lateral curvature of the spine as a scoliosis, which is a Greek word meaning to twist or to bend. It is acknowledged that bones will adapt their contours and positions according to the pressure which is brought to bear upon them, and this is especially true during the growing period. In a true scoliosis there is a flexion, side bending, and twisting of the vertebræ on their vertical axes. The spinal column is flexed and yields to the side of the relaxed muscular pull, the bodies of the vertebræ rotating

toward the convexity of the curve. The secondary compensatory curve in the opposite direction to the primary is due to nature's effort to maintain equilibrium. This is known as a double or S-shaped curve. Curves are referred to according to the location in the spine

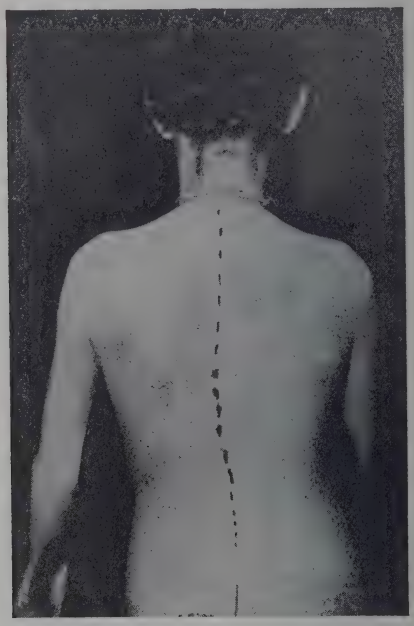


Fig. 107.—Left total curve.

that their convexities appear. If the convexity continues from the cervical to the dorsal region, or from the dorsal to the lumbar region, it is spoken of as cervicodorsal or dorsolumbar curve. If one convexity appears on the right side of the spinal column, and another on

the left side, the condition is spoken of as a right dorsal, left lumbar curve, or vice versa, according to the location of the convexity. Lateral deviations from the normal vertical spine will produce a lack of symmetry of

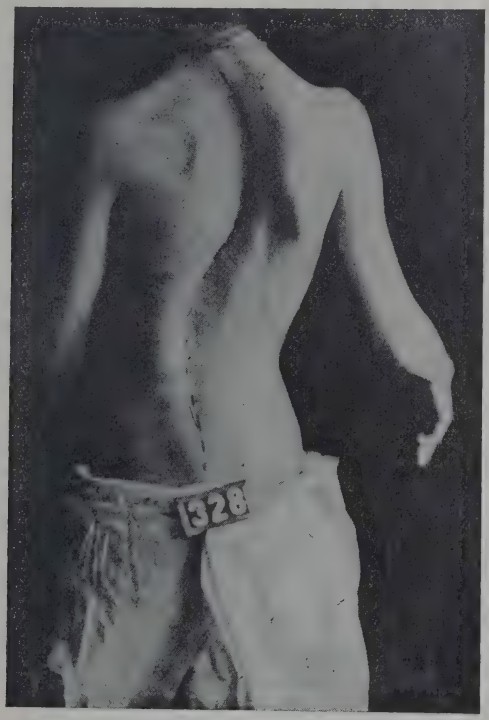


Fig. 108.—Scoliosis (right dorsal, left lumbar curve).

the two halves of the body. One shoulder is liable to be higher than the other, and the scapular angles uneven, or the hip line may show inequality, or there may be displacement of the trunk on the pelvic girdle. In the

early stage, before much strain has been placed on the spinal ligaments, and actual structural change has taken place, the daily practice of strenuous symmetric and specially adapted corrective exercises will help to build up the tone of the back muscles. At this stage the curve may respond to massage and corrective exercises. For the examination and treatment the back should be wholly exposed from the neck to the buttocks, and should be viewed in a good light. The patient is asked to stand at ease with the body weight evenly distributed on both feet. The line of the spinous processes should be noted, and, if necessary, each spinous process marked with an eyebrow pencil. The symmetry of each side of the back and chest should be observed and relative height of the shoulders, scapulæ, hips, as well as the position of the feet while standing. The type of figure, whether skeletal or stocky build, should be noted, and the general muscle tone. If one hip is higher than the other, to ascertain the difference in the length of the legs have patient place the foot of the short leg on a wooden block. It is advisable to have several blocks of different thicknesses, varying from $\frac{1}{4}$ to 2 inches. Measurements to ascertain the length of each leg are taken from the anterior superior spine to the internal malleolus while the patient is lying down. A cork inner sole or lift on the heel will help to correct the inequality in the length of the legs. Tilting of the trunk on the pelvis on the convex side of the curve will produce the prominence of one

hip and the flattening of the other. From the standing, fully forward stooped position, the rotation of the vertebræ is very readily seen by the rounding of the back on the convex side. With the patient in the prone lying position (thus relieving superimposed weight) the rotation will disappear if the curve is of the postural or slight structural type. In the same type of curve the rotation will also disappear if the patient is suspended by the arms or by the head. An *x*-ray picture will show how much vertebral rotation and structural change has taken place. If the rotation is slight, exercise treatment should be of a more vigorous nature than for the strictly postural type, and will necessarily take a longer time to show improvement. In the slight structural type, a corrective brace is sometimes worn during the period of muscle building, which may continue for a year or two. In the advanced structural type exercises are of little avail, except as preparatory to forcible correction by means of a plaster cast or other mechanical device. Overcorrection and retention in this position cover a long period of time, until the tissues have adapted themselves to the change of position. If a plaster cast is worn, felt pads are inserted through windows which are cut in the cast, and pressure is exerted over the convexities, both in the front and at the back. The pads are drawn through by means of a bandage. The windows in the cast allow for expansion of the concave parts and constant pressure is exerted over the convexities. Extra

pieces of felt are inserted weekly to give more pressure. Every two or three months a new cast is applied, and in severe cases these permanent casts are worn for a year or two, at the end of which time a removable jacket or brace is substituted, and massage and gymnastic treatment is commenced. If the patient is taught diaphragmatic breathing before the first cast is applied, and these exercises are practised daily during the months that the cast is worn, expansion of the concave ribs through the windows is hastened by means of the deep breathing, and correction is facilitated. Exercises are much the same following forcible correction as for those of the postural or the slight structural type of curve, therefore they will not be considered separately.

If the spine is rigid, exercises for flexibility play an important part. If there is extreme rigidity, it is advisable to use apparatus to exert pressure. The paddle exercise is excellent. (See Fig. 103, A and B.) The apparatus is so simple in construction that any carpenter can make it. It consists of a piece of wood about 45 inches long, one end of which is rounded to form a handle. The other end is flat and padded, and about 4 inches wide. It is applied in the following manner: The patient lies face downward, a round pillow or rolled towel being placed on the table at the level of the shoulders, and the upper part of the chest rests on the roll. The operator stands at the handle end of the paddle which is placed with the paddled end across the most rigid part of the

spine. The covered end of the paddle is attached to the table by means of a strap and buckle, and firm manual pressure is brought to bear on the rigid portion of the dorsal spine. The pressure should be slight at first, and should be gradually increased. Another good apparatus for gaining flexibility in an overrigid spine is the Sayre head sling, used in conjunction with a band of 3-inch webbing, about 48 inches long, encircling the chest. At each end of the band is a strong metal ring, and the two rings come together in front of the chest. From this point are attached ropes and pulleys. A simultaneous pull is given by the operator and the patient, the operator standing in the best position to give the patient a forward push with the left hand, while with the other the patient is swung upward and forward. (See Fig. 105.) The diagonal, upward, chest strap pull is important. At the end of the upward pull the patient is allowed to snap back into position. The snap back is especially good in cases of excessive dorsal rigidity. It should be continued for some time in connection with posture training and voluntary exercises. The chest strap may be used separately without the addition of the head sling if desired.

In the spine which is already overflexible, exercises to increase flexibility, such as swinging, suspension of any kind, or circumduction, should be avoided. Emphasis upon the assumption and maintenance of corrected posture will help to overcome the tendency of overflexibility.

The keynote position is a self-corrected one (Fig. 109), from which breathing exercises and asymmetric arm stretching can be taken. At other times it is best to use symmetric exercises. A Sayre head sling for sus-

Fig. 109.—Keynote position. The patient places the hands in the best position for correction.

pension may be combined with suspended 4-pound dumb-bells (Fig. 110). The patient stands or sits, and forcibly raises the dumb-bells from the bent elbow position. At the same time the operator pulls

the ropes of the head sling so that the spinal muscles are well stretched. The patient holds the fully extended arm position for several seconds and then releases the dumb-bells. Still maintaining all the extension possible in the back muscles, the arms are returned to the up-

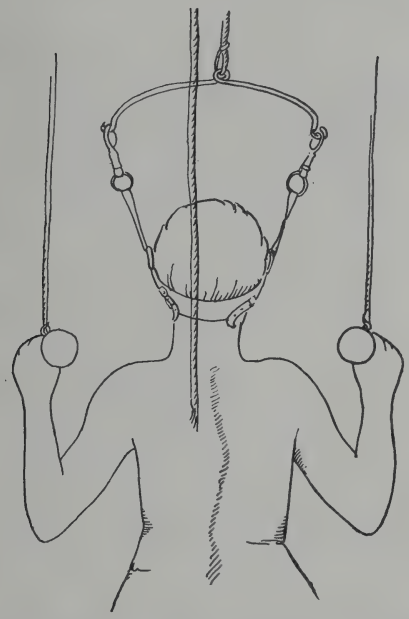


Fig. 110.—Combination of head sling and suspended 4-pound dumb-bells.

ward bend position. This exercise is repeated from five to ten times, and gradually the number of times is increased to twenty. This exercise brings very forcibly into play all the muscles of the back. To be effective, home work should be directed by a person with intelli-

gent interest and co-operation. An essential part of the treatment is rest following exercise. Lying in the Abbott frame for overcorrection for half an hour con-

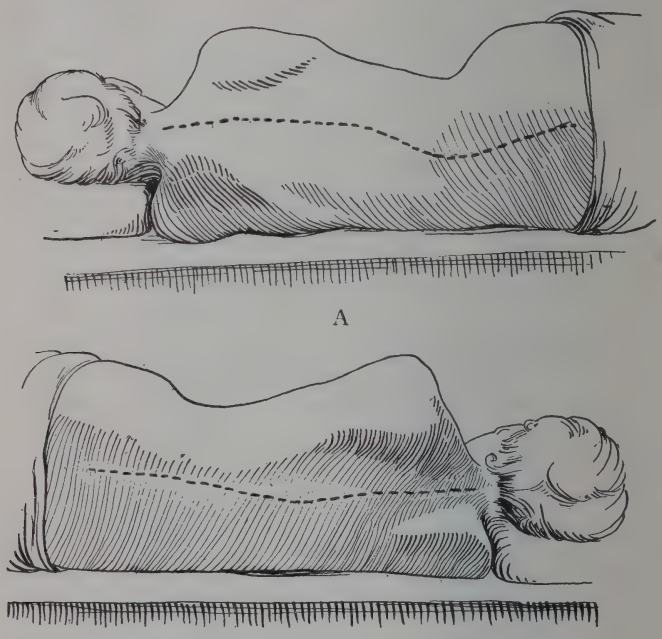


Fig. 111.—Left lateral dorsolumbar curve, slight convexity to right at middorsal, right hip prominent. A, Lying on left side increases lateral curves. B, Lying on right side corrects lateral curves and hip.

stitutes a good rest period following strenuous voluntary exercise. In certain cases, but not in all, lying on one side or the other has a distinctly corrective effect upon the curves. Each case differs; it is, therefore, im-

possible to lay down any definite rule. Lying first on one side, and then on the other and noting each time if any correction takes place in the back is the only possible way of testing. If correction in lying is possible, this should be drawn to the attention of the patient, and he should be advised to sleep in the corrected position (Fig. 111).

Operative measures have been used only recently and to a limited extent. After all possible correction has been obtained by exercises, a spinal fusion is done in the deformed area, thus providing a natural brace in the corrected position.

LIST OF EXERCISES FOR A LEFT TOTAL CURVE

1. Tall stretch standing, placing right hand on back of neck, left hand on hip, bend body to left. Inhale, return to position. Exhale. (Ten times.)

2. Balance walking, with a bag of beans carried on the head. Head held in good position, chin drawn in.

3. Sayre suspension apparatus, by means of which the body is slowly raised from the ground.

4. Standing left arm downward stretch, right arm from upward bend position (see Fig. 67) slowly upward stretch, holding 5-pound dumb-bell in right hand, return arm, and repeat. (Two to six times.)

5. Prone lying (feet held, pillow under abdomen), raise head and shoulders. The hands may be changed from the hips to the neck position and the body from above

the waist may hang over the head of the plinth. (Five to ten times.)

6. Throwing volley or basket ball overhead, from concave side (work up speed for flexibility).

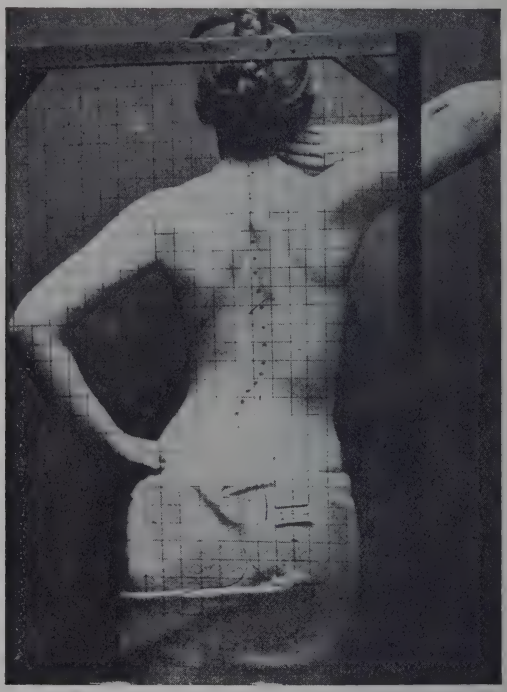


Fig. 112.—A keynote position. The patient is making a strong voluntary effort to correct deformity. The hands are placed in the best position for corrective muscular pull.

7. Spring sitting exercise (see Fig. 113). Reverse the exercises for a right curve.

8. Hanging from double rings, body from the waist swinging toward the left.

9. Hanging from trapeze with right arm higher than left, raise legs and stretch toward left.

10. Dr. Klapp advises the knee-hand position in which the patient creeps on the hands and knees. The hand of the side of the concavity is thrust forward as far as possible with each forward movement.

Fig. 113.—Spring sitting exercise, to be adapted to the individual needs of the patient.

The patient should be taught to commence all exercises by first adopting the keynote position. This is a position of self-correction. Asymmetric arm stretchings are given from the keynote position. Other exercises are symmetric (Fig. 112).

LIST OF EXERCISES FOR A RIGHT DORSAL LEFT LUMBAR CURVE

1. Hold corrected position. Right hand pressed against convex ribs, left hand on hip, inhale and exhale. (Ten times.)

2. Lying single and double, knee bending, stretching, bending and lowering slowly lumbar spine kept on floor. (Five times.)

Single leg raising and single knee bending and stretching should first be practised before double leg exercises are attempted.

3. Spring sitting exercise left thigh supported on stool, left arm stretching forward and upward, right arm stretching backward and downward along the side of the posterior leg which is stretched backward, trunk being inclined forward in line with backward leg. (See Fig. 113.)

4. Sayre head suspension apparatus (increasing flexibility). (See Fig. 106.)

5. Prone lying, feet held, hands on hips, raise head and shoulders. For progression the body from above the waist may hang over the head of the plinth. (Five to ten times.)

6. Hanging from double rings feet together on floor, body circumduction.

7. Kneel on left knee, hands on hips, bend body to right and slightly backward. (Ten times.)

8. Hanging from stationary bar (face out) flex both

knees to right angles, straighten knees, and repeat. (Five to ten times.)

9. Suspension by head sling and raising of 4-pound dumb-bells. The operator pulls the head sling rope so that the toes of the patient just touch the floor. The patient stretches the arms upward holding dumb-bells and brings the arms back to the upward bend without losing extension gained in the back muscles, but without the suspended dumb-bell (Fig. 110).

10. From keynote position arm extensions are best given in the best way of correction. (Ten times.) (Figs. 109–112.)

Reverse the exercises for a left dorsal right lumbar curve. Daily symmetric exercises should be taken regularly for two or three months before improvement may be expected. Kneading and effleurage of the muscles of the back, following exercises, will help to strengthen the back muscles. After exercises for spinal curvature the patient should rest for thirty minutes. The prone lying is a position by which the weight of the body is taken off the spine. Resting after exercise is an essential part of the treatment and should not be overlooked.

CHAPTER VIII

EMPYEMA: EXERCISES IN CASES OF CONVALESCING EMPYEMA AND ASTHMA. HERNIA: EXERCISES IN CASES OF HERNIA

EMPYEMA

It is quite common for an acute case of pneumonia to be followed by a purulent effusion in the lungs. After the acute stage has passed and during the convalescing period absorption of fluid may be hastened by therapeutic exercises. Stretching exercises are used on the affected side in order to prevent adhesions from forming or to break down those already formed. The lungs should be gently and gradually expanded by deep breathing exercises, which will increase the mobility of the chest walls. The lower trunk muscles may be strengthened by the use of abdominal exercises accompanied by diaphragmatic breathing. The lower trunk muscles lack tonicity because of labored and limited breathing. As a consequence, the general physical condition suffers. Ptosis is liable to follow as a result of the weakened abdominal muscles.

The patient should be taught how to take deep breaths, so that the base of the lung on the affected side may be thoroughly aërated.

Operative cases may be successfully treated by exer-

cise during the convalescing stage. Even after the resection of several ribs, in cases in which the hollow chest and spinal curvature symptoms are present, much benefit may be derived from daily systematic exercise. Gentle breathing exercises are started even before the drainage-tubes are removed.

Tuberculosis may follow as a result of empyema. It is essential that special emphasis is laid upon thorough aëration of the upper part of the lungs, as the bacillus is liable to harbor in this region. When possible, it is well that breathing exercises be carried on out of doors and the patient directed to make a regular habit of deep, slow, regular breathing.

ASTHMA

Asthmatic patients suffer from a disturbance of the nerve-regulating system of the breathing apparatus. The breathing is superficial; both inspiration and expiration are affected. The inspiration is short, and expiration is much too fast. This is especially true at the time of an attack, when inspiration becomes very quick and labored.

Little is known about the etiology of this distressing complaint. It does not confine itself to any particular age or sex. Change in altitude or climatic conditions will at times react favorably and break up an attack. Some asthmatic patients suffer from a hypersensitivity of the mucous membrane of the respiratory tract,

not infrequently also there are idiosyncrasies regarding certain kinds of foods. Tests for hypersensitivity and for food reactions are made and much is being done by inoculation to insure immunity. The object of therapeutic treatment is to try to educate the patient to better control in breathing. It is advisable to start training the rate and rhythm of breathing when the patient is feeling at his best. Any undue effort during the time of an attack is liable to react unfavorably on the breathing mechanism of the nervous system, and result in a greater degree of disturbance. Treatment may be started with the patient lying on the back, a pillow placed under the scapulæ to expand the chest. The knees should be flexed and supported with a small pillow, and from this position the patient is taught to take long, deep breaths, emphasis being placed upon a slow rate and even rhythm. The ribs should be well expanded during inspiration, encouraging the full excursion of the diaphragm, and expiration should be studied and slow. When a certain amount of control is gained, the same studied breathing should be attempted during the time of an attack. Pectoral stretching should be practised daily, as usually the chest is contracted. Apparatus (as in Fig. 102) is simple to install and insures most satisfactory results. Any exercise without apparatus that gives strong pectoral stretching may be used. The following exercises for empyema are also good for asthma, except that the trunk stretching in the latter is symmetric, while in

empyema the stretching is away from the affected side to prevent or break down adhesions.

EXERCISES FOR CONVALESCING EMPYEMA AND FOR ASTHMA

1. Stride standing, hands placed on lower ribs, resistance offered by the hands to force the ribs to expand during inspiration. Exhale. (Ten times.)

2. Stride standing, tall stretching, hands placed behind neck, deep breathing, holding the breath slightly at the end of inspiration and raising the shoulder girdle. (Ten times.)

3. Stride standing, alternate knee bending and stretching. (Two movements to each inspiration.) (Five times.)

4. Stride standing, hands on hips, trunk bending forward, raising to position (deep inspiration during trunk raising, expiration on trunk bending).

5. Stride standing, hands behind neck, trunk bending sidewards away from affected side, inhale. Return to position, exhale. (Ten times.)

6. Stride standing, arm raising sidewards. Trunk bending sideward from affected side. Affected side should be pushed out during inspiration, and returned to position during expiration. (Ten times.)

7. Stride standing, arm raising forward sideward, inhale. Downward, exhale. (Ten times.)

8. Sitting, one hand placed on each knee, inhale, and

at the same time separate the knees against the resistance exerted by the hands. Exhale, bringing the knees together against self-imposed resistance. (Five times.)

9. Standing, completely relaxing the spine, arms falling forward. From this position twist the trunk to the side opposite the affected one. From this position try to fall still further forward, inhale, return to position, exhale. (Three times.)

10. Arms raising sideward, hand turning, inhale. Return arms to position, slowly exhale. (Ten times.)

HERNIA

Hernia almost always occurs as a result of weakened abdominal muscles. The hernia protrudes through either the internal or the external abdominal ring. The internal oblique muscle lies between the transversalis muscle, which is the deepest of the group, and the external oblique muscle, which is the most superficial, forming the outer abdominal wall. The fibers of the external oblique run diagonally across the abdomen downward, forward, and inward. They originate from the eight lower ribs and are inserted into the crest of the ilium and the pubic spine and crest. The fibers at the insertion divide into two and are known as the inner and outer pillars. The part of the tendinous insertion extending from the anterior superior iliac spine to the pubic spine is thicker than the rest, its edges are curled back, forming a narrow shelf known as Poupart's ligament. The small

opening immediately above the pubic spine and between the pillars is the external ring through which the hernia is liable to protrude in men, this is known as inguinal hernia (Fig. 114). The fibers of the internal oblique

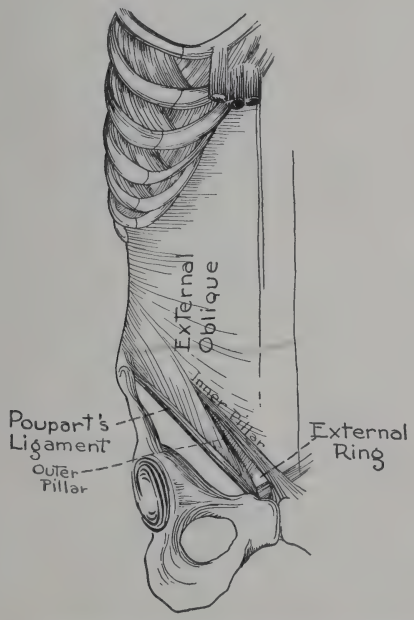


Fig. 114.—The external abdominal ring formed by a small opening in the external oblique tendon between its inner and outer pillar.

muscle run diagonally across the abdomen in the opposite direction to the external oblique. Beneath this is the transversalis muscle, the fibers of which run horizontally across the abdomen. The small oval opening at the lower part of the transversalis muscle about $\frac{1}{2}$ inch above the

middle of Poupart's ligament is the internal ring (Fig. 115) through which hernia usually protrudes in women. This is known as femoral hernia.

Of the two forms of hernia, femoral and inguinal, the latter is the more common.

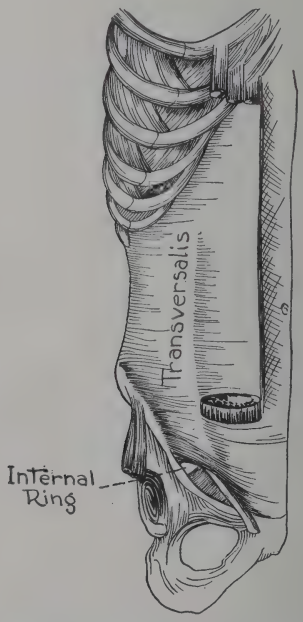


Fig. 115.—The internal abdominal ring formed by a small opening in the transversalis fascia.

The training of deep breathing and carefully supervised active exercises which twist the trunk away from the affected side are excellent as a preventive measure in threatened cases. Deep breathing raises the abdominal viscera and so relieves pressure and dilatation on the ab-

dominal muscles. Exercises which contract the external oblique muscle and close the external ring should be given. This can only be accomplished when the trunk is twisted away from the affected side. Straight trunk raising from the lying position should be avoided and pressure of the fingers or a truss should be exerted over the abdominal rings throughout the exercises.

EXERCISES FOR HERNIA

1. Lying, contract and relax the abdominal muscles. (Ten times.)

2. Prone lying, the fingers or a truss should bear constant pressure over the region of the abdominal rings on the affected side throughout the exercise. Raise the head and shoulders and twist the trunk away from the affected side. (Ten times.)

3 Supine lying, hands placed behind neck, knees straight. Flatten the lumbar spine, raise right leg, and slowly return to position. Repeat the same with the left leg. The knees should be kept straight throughout the exercise, with pressure by fingers or a truss over the abdominal rings. (Ten times.)

4. Standing, hands on hips, right knee upward bend, forward stretch, and return to position. Repeat same with left leg. (Five times each.)

5. Standing, strongly contract the abdominal muscles, slowly relaxing the spine, drop head and hands forward until full stooping position is reached, then

slowly return to position, holding the abdominal muscles in contraction throughout the exercise. (Truss worn.) (Two times.)

6. Hanging by hands, shoulder width apart, right knee upward bend, forward stretch. Return to position and repeat the same with the left knee. (Truss worn.) (Five times each.)

7. Hanging, same as in No. 6, both knees together upward bend, forward stretch, and return to position. (Truss worn.) (Two times.)

8. Sitting on floor, head, shoulders, and hips touching the wall. Try to get lumbar spine as near the wall as possible. Hold it there throughout the exercise. Raise right leg, return to position, and repeat with left leg. (Truss worn.) (Five times each.)

9. Sitting on stool, hands behind neck. Feet held securely. Incline the body backward and return to upright position. (Truss worn.) (Two times.)

10. Lying, feet held securely, rise to sitting position, head coming up in line with trunk. (Truss worn.) (Five times.)

Hanging exercises should only be given in the later convalescing period.

CHAPTER IX

CARDIOVASCULAR DISTURBANCES: THEIR TREATMENT BY THERAPEUTIC EXERCISES

Cardiovascular Disturbances.—The heart is the force pump which propels the blood through the body. It consists of two halves, each divided into two chambers, the auricle and the ventricle. The auricles and ventricles are composed of striped involuntary muscle known as myocardium. The chambers of the heart are lined with a perfectly smooth, thin, firm serous membrane known as endocardium. The same membrane also lines the blood-vessels. The valves which separate the auricles from the ventricles consist of folds of endocardium strengthened by fibrous tissue and fibrous rings.

The action of the heart is partly due to its nerve supply and partly due to the special form of heart muscle. At the junction of the superior vena cava and the right auricular appendix is the sino-auricular node. This is an aggregation of neuromuscular tissue which initiates the stimulus and sets both the pace and the rhythm of the heart. It is generally supposed that this node derives its fibers from the vagus nerve of the cerebro-spinal system and the accelerans of the sympathetic system. The vagus inhibits and the accelerans acceler-

ates the heart beat. The way in which the stimulus passes to the walls of the auricles and ventricles is not fully understood; but possibly it is conveyed by the action of the heart muscle, regular and complete contraction of which is necessary for regular contraction of the ventricles. Irregular and incomplete contraction of the auricles results in irregular contraction of the ventricles. In abnormal conditions the stimulus may not originate in the sino-auricular node, but in other parts of the nervous mechanism; for example, in premature systole the stimulus may arise in the auricle or the ventricle.

In exercise treatment of heart cases the operator should be especially observant to watch for undue pallor or a bluish tinge around the mouth of the patient, in which case exercises should be suspended until medical examination is made. All treatment by exercise in heart cases should be done only under direct and careful medical supervision. In the Nauheim-Schott treatment CO_2 baths and a system of resistive exercises, each of which are performed once only for each joint, constitute the method of treatment. In the Oertel method patients are given daily progressive walks with light hill climbing, the physician prescribing the length of walk, and also the combination of steps and breathing. In the beginning one or two steps are taken during each phase of respiration. With increased practice, while walking up hill, the patient may sometimes reach three steps during inspiration and expiration, without showing signs of

fatigue. Oertel teaches his patients to interrupt expiration two or three times if any sign of palpitation appears. He claims that this will have a direct mechanical influence on the heart. The Oertel treatment was designed to cure obesity in cases in which there existed marked low vascular tone. Providing there is little or no fatty degeneration present the results are likely to be satisfactory.

In the neurocirculatory type in which exercises have proved to be beneficial later, games that employ the larger muscle groups, provided overexertion is carefully guarded, are good. During the later convalescing period rowing, cycling, and golf, for which the graded exercises have served as a preparation, are especially helpful. The rhythmic action of deep breathing has a marked beneficial effect upon the action of the heart. Games and sports are good because they necessitate enforced deep breathing.

Sir William Stokes, about 1850, speaks of mountain climbing producing hypertrophy of the heart muscle, just as exercise will strengthen the skeletal muscles. In his article, "Diseases of the Heart," published in Dublin in 1854, he makes the following statement: "The symptoms of debility of the heart are often removable by a regulated course of gymnastics or by pedestrian exercises, even in mountainous countries, as Switzerland and the Highlands of Scotland and Ireland." Diet rich in albumin was recommended by Stokes, but

fluids were to be taken as sparingly as possible. He recommended avoiding the terrain-cure in cases of advanced arteriosclerosis. Hypertrophic degenerative changes may have taken place in the heart muscle, in which case dilatation would render compensation impossible.

In valvular disease, if degeneration is present and compensation fails, the diminished circulation in the arteries causes a congestion in the capillaries and veins on account of the failure of the heart to empty itself. This condition cannot usually be greatly assisted by therapeutic exercise. The local condition, however, may be helped by the general improvement in the circulation. Massage probably accomplishes that end with the least exertion to the patient.

A system of grades of exercises for cardiovascular disturbances has been found helpful in cardiovascular clinics of any size. The patient is placed in the grade to which he is best suited, and progresses from one grade to the next as his condition improves. An outline of grades that have been used with success is given below. The record of 2 cases suffering from cardiovascular disturbances have been added, and the average pulse-rate of a class of seven in Grades 2 and 3. In these cases the diagnosis and the pulse-rate both on entering and leaving the class is given. This report shows the different figures registering the pulse-rate both sitting and standing, before and after exercise. The figures show a lower-

ing of the pulse-rate after exercise. The improvement was not only temporary, but showed a slightly lower rate one hour after treatment. Commands in cardiovascular exercise are given in quiet slow rhythm.

EXERCISES FOR CARDIOVASCULAR DISTURBANCES

These exercises may be used for individuals or for classes.

Grade I. Patient is seated or in half-lying position. Every exercise is given with slow, even rhythmic breathing. During flexion the larger veins are filled, while during extension they are emptied. Start with one movement to each joint, and increase to five for each. Then add resistance, increasing the number of movements to ten for each joint.

1. Wrist. Passive flexion, inhale. Extension, exhale.
2. Elbow. Passive flexion, inhale. Extension, exhale.
3. Shoulder. Passive flexion, inhale. Extension, exhale.
4. Ankle. Passive flexion, inhale. Extension, exhale.
5. Knees. Passive flexion, inhale. Extension, exhale.
6. Hip. Passive flexion, inhale. Extension, exhale.

Passive exercises in Grade I are followed by carefully graded resistive exercises for each joint. (See Chapter II, Part I for grading of resistance.)

Grade II. In this grade the exercises should start with the patient in the lying position. If breathing is

difficult in this position, have the patient sit for the arm stretchings and stand for the leg exercises. The rhythmic breathing may be slightly faster than in Grade I.

Lying or Sitting:

1. Arm raising sidewards, inhale. Return to position, exhale. (Five each.)

2. Knee upward bending, inhale. Return to position, exhale. (Five each.)

3. From arm forward bend position, sideward stretch, inhale. Return to position of forward bend, exhale. (Five times.)

4. Arm and leg together sideward stretch, inhale. Return to position, exhale. (Five times.)

5. Alternate right and left straight leg raising, inhale. Return leg to position, exhale. (Five each.)

6. Arms outward roll, hand turning, inhale. Return hands to sides, exhale. (Ten times.)

Grade III. *Standing:*

1. From arm bend position, forward, sideward stretch, inhale. Return to position, exhale. (Five times.)

2. Head backward bending, inhale. Return to position, exhale. (Five times.)

3. Rise on toes, inhale. Bend knees, exhale. Return to rise on toes, inhale. Heels sink, exhale. (Five times.)

4. Hands on hips, place, trunk forward bend, exhale. Return to position, inhale. (Five times.)

5. Alternate right and left leg, forward sideward

stretch, inhale. Backward stretch and return to position, exhale. (Five times.)

6. Slow marching, gradually increase speed to jog-trot run. When the patient is able to graduate from Grade III, regular distance walking daily, gradually including short low grades or short flights of steps may be safely taken. Games of a strenuous nature should be carefully guarded against until there is no fear of further cardiodisturbance. Strenuous muscular effort accompanied by excitement is liable to increase the heart rate, which might prove harmful.

TWO TYPICAL CARDIOVASCULAR CASES TREATED BY THE GRADED EXERCISES DESCRIBED ABOVE, WITH THE RECORD OF PULSE AND IMPROVEMENT IN EACH CASE

Mr. L. C. B.—*Diagnosis:* Functional cardiac disorder, postinfective type. Nervous; short of breath on exertion; slight effort causes marked increase in heart rate.

Pulse on entering class, July 16th: Before exercise, sitting 116; standing 130. Pulse, July 28th: After exercise, sitting 72; standing 76. Marked improvement in pulse-rate. Much less increase in rate while standing. Colonel B. continued in class some time with more or less irregular heart rate from day to day. Before returning to duty, early in September, he was taking part in indoor baseball, batting, running, and fielding.

Mr. P.—*Diagnosis:* Postdiphtheric paresis of legs.

Functional cardiovascular disability; extrasystole. Foot strain.

Pulse-rate on entering the class July 17th was 116. Pulse-rate August 1st: Before exercise, sitting 72; standing 80. After exercise, sitting 72; standing 76. One hour after exercise was not transient.

In these cases the decrease of pulse-rate after the exercises was notable for its constancy.

The average pulse-rate for classes in the various grades is as follows:

Grade II, seven men in class, July 28th: Before exercise, sitting, $85\frac{2}{3}$; standing, $102\frac{2}{3}$; after exercise, sitting, 80; standing 93. August 5th: Before exercise, sitting, $81\frac{2}{3}$; standing, 91; after exercise, sitting 79; standing, $84\frac{2}{3}$.

After exercise, July 28th, pulse increases on standing 13; on August 5th, 50. It was found on examination one hour after exercise that the pulse-rate in most cases was still lower than immediately after exercise.

Grade III, 13 in class, July 28th: Before exercise, sitting, $85\frac{1}{2}$; standing, 98; after exercise, sitting, 84; standing, 92. August 5th: Before exercise, sitting, 86; standing, 92; after exercise, sitting, 82; standing, $86\frac{1}{2}$.

CHAPTER X

EXERCISES FOR ATAXIC CONDITIONS (TABES DORSALIS); EXERCISES FOR SPASTIC PARALYSIS (HEMIPLEGIA)

ATAXIC CONDITIONS (DR. FRENKEL'S EXERCISES)

TABES dorsalis, or locomotor ataxia, is discussed in Chapter VIII, Part I. If "shooting or lightning" pains exist, a short period given to gentle stroking of the affected limbs may have a sedative effect before any exercises are given. If no pain exists, massage may be omitted, but exercise has an important place in the treatment.

In his exercises for tabetic patients Frenkel's idea is to substitute healthy working nerves for the affected ones, as much as possible, thus compensating somewhat for disturbed function. The patient's attention must be continuously held by the operator. It is better to have two periods of ten minutes' exercise twice daily, than to have a longer period at one time. This is especially true at the start. The patient should never be overtired, or the movements will become less co-ordinated. The dosage in exercise may be gradually increased with safety. Frenkel divides his exercises for tabetic ataxia into four divisions: Those given in the lying position, the sitting position, the standing position, and the walking position. In the lying position the head and

shoulders should be raised. The patient is instructed to concentrate his attention on each movement. Each of the following movements should be performed slowly three or four times:

1. Lying:

(1) Flexion and extension of each leg at the knee- and hip-joints. Abduction and adduction with the knee bent, later abduction and adduction with the knee extended.

(2) Flexion and extension of one knee at a time with the heel raised from the bed.

(3) Knee flexed and heel placed upon some definite part of the other leg; for example, on the patella, the middle of the leg, ankle, and toes. These exercises may be given by changing the heel from one position to another, or else by calling for extension between the different placings.

(4) Knee flexed, heel placed on knee of other leg, heel of flexed leg gliding down the tibia to the ankle-joint and back to knee.

(5) Flexion and extension of both legs, together with knees and ankles held close together.

(6) Flexion of one leg during extension of the other.

(7) Flexion or extension of one leg during adduction or abduction of the other.

When the performance of the above exercises becomes easy, the patient should repeat them with the eyes closed.

(8) From the sitting position the patient tries to definitely place his foot in the hand of the operator while the operator constantly changes the position of the hand. Exercises may be given by means of special apparatus, consisting of a board with holes in which to place the heels and a bar which may be placed across the bottom of the bed at different heights and varying distances. The patient is encouraged to place his heels in the holes, the position of the board being changed after each attempt.

(9) The patient maintains the fundamental sitting position for a few minutes at a time.

(10) Raising each knee alternately and placing foot firmly on the ground upon a traced footprint.

(11) The patient is taught to rise from a chair and sit again with knees held together.

(12) Foot placings forward and backward on a straight line. These exercises should be followed by walking maneuvers; *e. g.*, walking along a zigzag strip following markings.

(13) Walking between two parallel lines.

(14) Walking, placing each foot on tracing on floor which should be marked in fairly close adduction position, straight line walking (not toe out).

If the upper extremities are affected, writing and drawing exercises are helpful. Holes marked, colored, and numbered on a board, the patient is asked to place his finger on a certain color and a number at a point of command. These exercises are beneficial for co-ordina-

tion and deliberate action building. In order to improve general benefit to the constitution, trunk flexions and extensions with deep breathing will aid systematic circulation, and so encourage both the flow of blood and lymph through the deep muscles of the back, thus aiding nourishment around the spinal roots of the nerves.

PROGRESSIVE COMPETITIVE EXERCISES IN CASES OF SPASTIC PARALYSIS (HEMIPLEGIA), BASED UPON DR. SHEPERD IVORY FRANZ'S THEORIES

HEMIPLEGIA

Hemiplegia is discussed in Part I, Chapter VIII. Dr. Shepherd Ivory Franz, of Washington, D. C., has successfully demonstrated the exemplification of his ideas of competitive game exercises upon hemiplegics. At St. Elizabeth's Hospital he has organized a baseball team. The results from both the mental and physical standpoints are encouraging. A list of exercises incorporating Dr. Frank's ideas will be given below:

1. Standing with the affected arm sideways near the wall, the patient is instructed to swing the spastic arm in flexion and extension, and to touch the wall. A mark on the wall should be made at the highest point reached, and the patient encouraged to reach a little higher each day.

2. The patient holds a tennis ball in the hand.

   (*a*) Drops ball maximum number of times in three minutes. (Time to be strictly kept and recorded daily.)

Ball is placed in hand by operator.

Ball is placed in hand by patient.

(*b*) Stands on a line, swings arm and throws ball in basket.

Count number of times ball enters basket.

Count number of times ball is dropped back of line before thrown.

Count number of times ball is unable to be released on extension or swing of arm.

3. The patient kicks football five times with the leg extended.

4. Chalk lines on floor, with numbered divisions:

1	2	5	3	1

The patient stands 10 feet from target: Kicks tennis ball, twenty-five trials, and score is kept. Start with ten trials or less.

5. Exercise with hand same as No. 4 for foot. This exercises the relaxed extensor groups.

6. Step over stringed jumping standard; keep record each day of height (for the abductors).

7. Hand spring, for testing strength of grip, a two-minute rest should be observed between trials:

(*a*) Strong hand four times alone.

(*b*) Weak hand four times alone.

8. A volley ball may be used for the following exercises:

(*a*) Catch ball with arm bent at elbow. Score should be kept.

(*b*) Thrown ball in basket (which is placed in a low position) with both hands. Keep score.

9. Run (record time and distance) from a few steps to twenty-five yards.

10. Bat baseball. Score number of hits.

A daily record should be kept for each patient. Hard balls should never be used, for fear of hurting the patient.

APPENDIX

REQUESTS are frequently made for a list of suitable equipment for a Physiotherapy Department. Minimum equipment would necessarily vary for civil hospitals according to the size of the department and also the type of hospital from which the Physiotherapy Clinic would draw its patients. From this it will be clearly seen that it is only possible to give a general idea of equipment. A large room with plenty of windows for ventilation and sunlight may be partitioned into three sections. One end of the room may be equipped as a Corrective Gymnasium, while the other end may be divided into two, one section having electrotherapy equipment and the other a hydrotherapy plant. Elaborate equipment is unnecessary and will not be considered. Any carpenter should be able to make the plinths or any of the gymnasium apparatus.

MINIMUM GYMNASIUM EQUIPMENT

1. Wooden plinths or tables, length 6 feet 6 inches, width 28 inches, height 30 inches (Fig. 116, A).

2. Several wooden stools of varying heights (Fig. 116, B).

3. Small wooden blocks varying in thickness from $\frac{1}{4}$ inch to 2 inches.

4. Large triple mirror for posture training.

5. Two wooden uprights, height approximately 8 feet 6 inches, from which may be suspended:

Trapeze.
Two large iron rings.
Sayre head sling (Fig. 106).

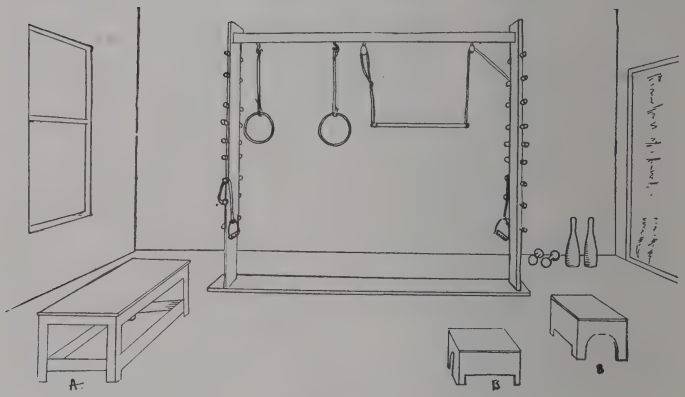


Fig. 116.—Gymnasium with apparatus.

6. Pectoral stretching apparatus consisting of two handles which are attached to ropes, one from each upright (Fig. 102). For method of applying apparatus see page 265.

7. The paddle apparatus (Fig. 103). For method of applying apparatus see page 278.

8. The McKenzie apparatus in conjunction with the Sayre head sling (Fig. 105). For method of applying apparatus see page 279.

9. Several pairs of 1-, 2-, and 4-pound dumb-bells and Indian clubs.

10. Several dark gray blankets, small hair pillows.

11. White crepe one-piece sleeveless robes, tied behind, are useful during examination.

12. Filing cabinet with card catalogue index system for keeping records, *x*-ray findings, and for prescriptions.

MINIMUM ELECTROTHERAPY EQUIPMENT

1. One large high-frequency machine capable of delivering an adequate autocondensation.

   Approximate cost, $500.

2. One deep therapy 1000-watt light.

   Approximate cost, $125.

3. Three type "I" applicators equipped with 8 incandescent lights.

   Cost, $40 apiece.

4. One air-cooled ultraviolet outfit.

   Approximate cost, $400.

5. One portable high frequency for diathermy.

   Approximate cost, $275.

6. Accessories for high frequency.

   (*a*) One autocondensation pad.

   (*b*) One metal handle for autocondensation.

   (*c*) Ten pounds of block tin, gage 22 (for diathermy).

   (*d*) One fulguration electrode.

   (*e*) One universal handle for vacuum tubes.

(*f*) Two surface vacuum electrodes.

(*g*) One curved-stem double vacuum electrode.

(*h*) Ear vacuum electrode.

7. One galvanic sinusoidal machine.

   They vary in price in accordance with the current sources at the hospital. A motor generator may be necessary to change the alternating to direct current.

8. One galvanic controller with meter.

9. One Bristow Faradic coil.

   (*a*) One nerve tester with interrupter handle.

   (*b*) Six pairs of conducting cords (rheophores.)

   (*c*) Six asbestos type electrodes—4 x 5 inches.

   (*d*) Six asbestos type electrodes—3 x 9 inches.

   (*e*) Six asbestos type electrodes—5 x 7 inches.

   (*f*) Absorbent cotton, or cellucotton, in order to have a fresh electrode covering for each patient.

   (*g*) Two round electrodes, asbestos covered, with wooden handles.

HYDROTHERAPY PLANT

The price of hydrotherapy tables ranges from $500 upward for installation. The following simple arrangement may be installed by any plumber at comparatively small cost and will prove to contain all the necessary equipment for showers, douches, sprays, etc.

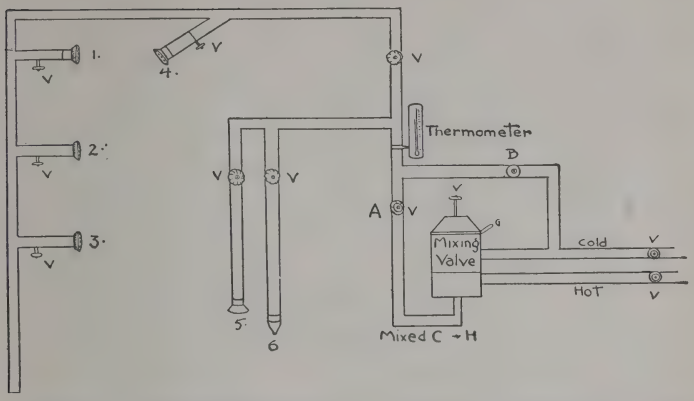


Fig. 117.—Hydrotherapy plant: V, Valves controlling all outlets (1 to 6); A, mixture of hot and cold leaving mixing valve; B, offshoot from cold supply pipe; G, governor for mixing valve controlling temperature of A outlet.

When straight cold is desired, simply open valve B. This cuts off cold supply to mixture chamber and throws cold into main feed pipe to outlets.

Closing Valve B puts mixing valve into operation again.

B valve is closed when warm mixture is desired.

When maximum cold is desired, close Valve A and open Valve B.

Valves 1 to 4 have ball-and-socket unions for setting spray at an angle.

Line to Valves 5 and 6 is flexible hose and may have as many separate outlets for foot and band baths, etc., as desired.

Entire apparatus may be installed in space of 3 x 5 feet.

All piping is exposed. May be mounted on wall or tube frame from floor.

Governor permits any given temperature for all or single outlets and also will give contrast temperatures.

Sharper contrasts may be had by setting the governor at the highest temperature required and operating Valve B for contrast effects.

Valves 1, 2, and 3 are placed at heights convenient for treating any part of the body. Valve 4 at a convenient height and distance opposite 1, 2, and 3 to permit patient receiving streams to front and back at same time.

According to space available, more outlets may be added to the plan as desired.

A few foot-tubs should be all the extra articles required with the exception of a generous supply of heavy bath towels and blankets. Electric light cabinets range in price from $600 upward, and, if used, should be placed as close to the shower apparatus as possible, as they are always used in combination with showers and douches.

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